journalism and media

MDPI

Article

Human Competencies at the Edge of Automation: A Qualitative Study of AI Integration in Frontline Journalism

Hyeyun Jung

RCBDSI & EIS Lab, Korea University, Seoul 02841, Republic of Korea; unefly@naver.com

Abstract

The integration of AI into journalism has intensified debates about the future of news production, yet existing scholarship has focused predominantly on AI's capabilities rather than on irreplaceable human competencies. This study shifts analytical focus from replacement to complementarity, investigating the boundaries of AI through the perspectives of both journalists and AI developers. Ten participants—including field reporters, news anchors, broadcast journalists, and AI developers—were interviewed through in-depth, semi-structured interviews. Thematic analysis revealed three core dimensions of irreplaceable human competency: embodied presence and rapport-building, contextual judgment and meaning-making, and investigative initiative requiring moral agency. Practitioners and developers converged on AI's persistent limitations in factual reliability, emotional authenticity, and ethical accountability. Based on these findings, a three-tier human–AI collaborative model is proposed, allocating computational tasks to AI while preserving human authority over editorial judgment, source relationships, and ethical decisions. These findings contribute to human–machine communication theory, extend algorithmic journalism literature beyond capability assessments, and offer practical implications for newsroom workflow design, journalism education, and AI governance. Findings are situated within the Korean media context and should be interpreted accordingly, with implications that may extend to other broadcasting-oriented journalism cultures.

Keywords: AI journalism; human–AI complementarity; computational journalism; professional identity; news production; embodied reporting

1. Introduction

Artificial intelligence (AI) has become one of the most consequential forces reshaping the contemporary newsroom. From automated content generation and natural language processing to algorithmic curation and predictive analytics, AI tools are increasingly embedded in the daily workflows of journalists and news organizations across the globe (Dodds et al., 2026a; Porlezza & Schapals, 2024; Newman, 2026). A recent systematic review documented a 172% surge in AI-related journalism publications in 2024 alone, reflecting the extraordinary pace at which both the technology and scholarly attention to it have expanded (Al Masum Molla & Ahsan, 2025; Calvo-Rubio & Ufarte-Ruiz, 2021). Yet, despite this rapid proliferation, a significant asymmetry persists in how researchers and industry actors have framed the relationship between artificial intelligence and human journalistic practice: the dominant narrative continues to center on AI's capacity to replace, automate, or supplement journalists, while comparatively little attention has been devoted to understanding the boundaries of that capacity and the distinctive competencies that human practitioners bring to news production.

Check for updates

Academic Editors: Eglée Ortega Fernández and Carmen Llovet

Received: 18 February 2026
Revised: 31 March 2026
Accepted: 6 April 2026
Published: 14 April 2026

Copyright: © 2026 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license.

This framing asymmetry reflects a broader tendency within the algorithmic journalism literature to evaluate AI primarily through the lens of efficiency and scalability—metrics that naturally privilege technological capability over the complex, often tacit dimensions of journalistic work that resist quantification. Frontline journalism—encompassing field reporters, news anchors, and broadcast journalists who engage directly with sources, audiences, and live events—occupies a neglected position within this discourse. While scholars have examined AI's role in data-driven reporting, automated text generation, and editorial decision-making, the practice of direct journalistic engagement—characterized by embodied presence in field reporting, real-time judgment in live broadcasting, source relationship management across multiple contexts, and ethical accountability in high-stakes environments—has received far less critical interrogation in relation to AI adoption (Broussard et al., 2019). This gap is consequential because frontline journalism represents precisely the domain in which the limitations of current AI systems are most starkly visible and in which the question of complementarity versus replacement carries the greatest professional and societal weight.

The present study intervenes in this conversation by shifting the analytical focus from what AI can do to what it cannot and, from there, to how human and artificial intelligence might be most productively configured as collaborative rather than competitive forces within news production. Drawing on in-depth semi-structured interviews with 10 practitioners—two field reporters, two broadcast journalists, three news anchors, one newspaper journalist, and two AI journalism developers—this research seeks to map the functional and conceptual boundaries between human and machine capability in journalism. Crucially, the inclusion of AI developers alongside frontline journalists allows the study to triangulate practitioner experience with insider knowledge of technological development trajectories, yielding a richer understanding of both current limitations and near-future possibilities than either perspective alone could provide.

These questions are situated within a complementarity framework—a perspective that moves beyond the binary of replacement or augmentation to articulate how technologically mediated professional practice can preserve the epistemic, ethical, and relational dimensions that define journalism as a public-interest enterprise. By centering the voices of those who inhabit this landscape daily—reporters navigating crisis zones, anchors mediating live broadcasts, and developers building the tools that will shape tomorrow's newsrooms—this study contributes to both the empirical literature on AI adoption in media and the theoretical conversation about professional identity and technological disruption in journalism. This study is situated within the Korean media context, focusing on Korean and Korean American broadcast and print journalism practitioners.

2. Literature Review

2.1. Theoretical Foundations: From Replacement Paradigm to Complementarity Framework

2.1.1. Human–Machine Communication (HMC) Theory

Human–machine communication (HMC) theory (Guzman, 2018; Guzman & Lewis, 2020) reconceptualizes technology from a mere channel to a communicative agent. Lewis et al. (2019) identify three dimensions relevant to journalism: functional (how practitioners make sense of AI as communicators), relational (how journalists associate with these technologies), and metaphysical (implications of AI presence in news production).

Bourdieu's field theory (Bourdieu, 1998; Szeman, 2000; Benson & Neveu, 2005) conceptualizes journalism as a structured social space where practitioners compete for economic, cultural, and symbolic capital (Benson, 2006; Schultz, 2007). Recent scholarship demonstrates field theory's utility for examining technological transformation (Maares & Hanusch, 2020; Lindblom et al., 2024), revealing how digitalization reconfigures field boundaries

and habitus. AI's integration has accelerated the presence of new actors—developers, data scientists—within newsrooms, further blurring traditional distinctions between journalistic and technological expertise that began shifting with the advent of web and mobile platforms decades earlier (Lischka et al., 2023; Borges-Rey, 2016; Örnebring, 2010). For this study, field theory illuminates questions of professional identity, jurisdictional boundaries, and power dynamics when AI systems and developers enter the journalistic field (Kosterich, 2020; Wu, 2024).

2.1.2. Toward a Complementarity Framework

The dominant discourse in AI journalism scholarship has historically privileged a replacement-oriented paradigm, emphasizing AI's capacity to automate, substitute, or enhance human labor (Graefe & Bohlken, 2020; Thurman et al., 2019). A growing body of literature now calls for reorienting this discourse toward complementarity—a framework that articulates how human and artificial intelligence might be configured as collaborative rather than competitive forces (Dodds et al., 2026b; Londoño-Proaño & Buele, 2025). This reorientation builds on earlier scholarship documenting journalism's persistent capacity to adapt to automation rather than be displaced by it, with human professional identity and ideological commitment emerging as key mitigating forces (Linden, 2017).

The complementarity framework integrates the theoretical perspectives outlined above to create a multi-level analytical lens. At the micro level, HMC theory illuminates how individual practitioners perceive and interact with AI systems as communicative agents, revealing functional boundaries in specific tasks. At the meso level, Bourdieu's field theory explains how AI integration reshapes professional hierarchies, forms of capital, and jurisdictional boundaries within journalism as a social field (see Table 1).

Table 1. Theoretical framework contributions to the study of AI in journalism.

Theory	Level of Analysis	Key Concepts	Application to Present Study
Human–Machine Communication (HMC) Theory	Micro (Individual)	• Functional dimensions • Relational dynamics • Metaphysical implications • Communicative agency	Examines how practitioners perceive AI as a communicative agent; reveals boundaries in specific tasks
Bourdieu's Field Theory	Meso (Organizational)	• Forms of capital (cultural, social, symbolic) • Habitus • Boundary work • Power dynamics	Analyzes how AI integration reshapes professional hierarchies and jurisdictional boundaries
Complementarity Framework	Macro (Systemic)	• Human–AI collaboration • Differentiated contribution • Functional specialization • Synergy over replacement	Provides a normative framework for configuring AI to preserve journalism's epistemic and ethical dimensions

HMC = human–machine communication. Levels of analysis follow multilevel framework conventions (micro, meso, and macro).

2.2. Empirical Landscape: AI Adoption and Journalist Perceptions

2.2.1. Current Applications of AI in Newsrooms

AI's integration into journalism follows decades of newsroom automation. Early template-based systems (1990s) evolved into sophisticated platforms deployed by *AP* and *LA Times* for routine reporting (Clerwall, 2017; Graefe, 2016; Dörr, 2016; Canavilhas, 2022).

2.2.2. Journalist Perceptions: Opportunities and Concerns

Qualitative research reveals complex attitudes toward AI. Cools and Diakopoulos (2024) identified 16 distinct uses of generative AI across reporting processes, while Wu et al. (2019) found Danish journalists using AI primarily for routine tasks while emphasizing human-led editorial judgment. Wu (2024) documented "value-motivated use," showing journalists selectively adopt AI tools, preserving professional values of accuracy and accountability. Barriers include infrastructure gaps, insufficient training, algorithmic opacity, and employment concerns (Gondwe, 2025; Munoriyarwa & Chiumbu, 2024; de-Lima-Santos & Ceron, 2021). While journalists acknowledge AI's operational utility, they express reservations about its contextual, ethical, and relational capacities (Carlson, 2018; Túñez-López et al., 2021).

2.2.3. The Overlooked Domain: Frontline Journalism and Direct Engagement

A significant gap in the existing literature concerns frontline journalism—the practice of direct journalistic engagement encompassing field reporting, live broadcasting, and real-time source interaction, all characterized by physical or communicative presence, relationship management, and immediate contextual judgment (Broussard et al., 2019; Dodds et al., 2026a). While scholars have extensively examined AI's role in data-driven reporting and automated text generation, the domains where human journalists most distinctively operate—whether at crisis zones requiring embodied presence, in broadcast studios demanding real-time editorial judgment, or across contexts requiring relational trust with sources—have received far less critical attention. This omission is consequential for several reasons. First, frontline journalism represents precisely the domain where AI's limitations are most starkly visible; no current system can substitute for a reporter's physical presence at a scene, an anchor's real-time judgment during breaking news, or the ability to read non-verbal cues and build trust with vulnerable sources over time. Second, frontline journalism embodies journalism's core democratic function as a witness to and communicator of events of public significance—a function that carries profound ethical weight not easily delegated to machines.

2.3. Research Questions

RQ1: What human competencies do current AI systems fail to replicate in the context of news reporting, as identified by field journalists, news anchors, and AI developers?
RQ2: What limitations of AI in journalism are commonly recognized across practitioner and developer perspectives?
RQ3: How can the identification of these human strengths inform future directions for AI development in the media sector?
RQ4: What collaborative models might be designed to maintain journalistic standards while leveraging the complementary strengths of both human and artificial intelligence?

3. Methods

3.1. Research Design

This study adopted a qualitative research design grounded in reflexive thematic analysis (Braun & Clarke, 2021) to investigate the boundaries of artificial intelligence in journalism through the perspectives of frontline practitioners.

3.2. Participants and Sampling

Participants were recruited through purposive sampling, a strategy appropriate for qualitative research seeking information-rich cases that can illuminate the phenomenon under investigation (Patton, 2015). The final sample comprised ten participants: two field

reporters, two broadcast journalists, three news anchors, one newspaper journalist, and two AI journalism developers. This sample size aligns with established guidelines for qualitative interview studies, where 10–15 participants typically suffice to achieve data saturation when the study focuses on a well-defined professional group (Guest et al., 2006; Hennink et al., 2017). Data saturation was reached by the eighth interview, with the final two interviews serving as confirmatory.

Field reporters (n = 2) met the criteria of 10+ years of on-location reporting experience, breaking news coverage, and direct source engagement in sensitive contexts. Broadcast journalists (n = 2) were defined as reporters who combine studio-based and field reporting responsibilities, typically involved in producing television news segments. Selection criteria included (a) a minimum of 10 years of broadcasting experience, (b) involvement in both field reporting and studio production, and (c) direct experience with editorial decision-making. Newspaper journalists (n = 1) were included to provide a comparative perspective from print media contexts where AI adoption patterns may differ from broadcasting environments.

News anchors (n = 3) were selected for their real-time editorial judgment, live broadcast mediation, and dual role as both information presenters and editorial gatekeepers. AI journalism developers (n = 2) were defined as technologists directly involved in building, deploying, or strategizing AI tools for news production, with selection requiring (a) a minimum of 10 years of media technology experience, (b) hands-on involvement in AI journalism applications, and (c) an understanding of both technical capabilities and journalistic constraints.

Participants ranged in age from early 30s to late 50s (inferred from having 10–35 years of professional experience), represented diverse organizational contexts (terrestrial broadcasting, regional media, international news, and media technology firms), and included both Korean and Korean American practitioners. Table 2 presents participant demographic and interview details.

Table 2. Participant demographics and interview details *.

ID	Professional Role	Years of Experience	Media Type	Interview Date	Duration (min)
P1	Field Reporter	12	Korean Broadcasting (New York)	26 September 2025	145
P2	Broadcast Journalist	22	Terrestrial Broadcasting (National)	29 September 2025	178
P3	Field Reporter	15	Regional Broadcasting	30 September 2025	132
P4	Anchor/Reporter	35	Terrestrial Broadcasting (National)	8 October 2025	168
P5	Regional Announcer	18	Regional Broadcasting	29 October 2025	125
P6	Broadcast Journalist	10	Terrestrial Broadcasting (National)	14 November 2025	155
P7	Newspaper Journalist	30	Daily Newspaper (National)	5 December 2025	142
P8	Cable Announcer	5	Cable Broadcasting (Local)	12 January 2026	162
P9	AI Journalism Developer	14	Media Technology Company	28 January 2026	138
P10	AI-Related Professional	11	Media Technology Planning	3 February 2026	175

* All interviews were conducted between 15 August 2025 and 3 February 2026. Mean interview duration = 152 min. IRB approval: P01-202509-01-085.

This study received ethical approval from the Korea Public Institutional Review Board (P01-202509-01-085) on 23 September 2025, with approval valid through 22 September 2026. All participants provided written informed consent after receiving detailed information about the study's purpose, procedures, risks, and their right to withdraw at any time without penalty. To protect participant confidentiality while preserving contextual richness, participants are identified using alphanumeric codes (P1–P10) rather than names or organizational affiliations.

3.3. Data Collection

Data collection occurred between 26 September 2025 and 3 February 2026 through semi-structured in-depth interviews with ten participants. Each interview was conducted once, with durations ranging from 125 to 178 min (M = 152 min). The extended interview length was intentional, designed to create a conversational environment where participants could speak freely beyond structured questions and develop rapport with the researcher—an approach consistent with reflexive thematic analysis principles (Braun & Clarke, 2021). All interviews were audio-recorded with participant consent and transcribed verbatim by the research team. The full interview protocol is provided in Appendix A.

3.4. Data Analysis

Analysis followed Braun and Clarke's (2019, 2021) reflexive thematic analysis through six phases: familiarization, systematic coding (127 preliminary codes, 18 categories, 6 themes), theme development, refinement, and reporting. The researcher maintained analytical memos and engaged in peer debriefing with two qualitative researchers who independently reviewed coded transcripts A detailed codebook is provided in Appendix B. Representative quotations were selected for conceptual clarity, experiential richness, and typicality. Korean-to-English translation prioritized semantic equivalence and conceptual fidelity while preserving professional register.

3.5. Reflexivity and Trustworthiness

Trustworthiness was enhanced through several strategies. Prolonged engagement with the data—including multiple rounds of coding and theme refinement over a six-month period—supported depth of analysis. The multi-stakeholder sample design enabled triangulation across perspectives. Member checking was conducted with all ten participants: each received a summary of themes and selected quotations attributed to them, with an invitation to verify accuracy and clarify meanings. Nine participants confirmed the interpretations without modification; one participant (P4) requested minor clarification regarding organizational context, which was incorporated. Finally, the study's transparent reporting of methodological procedures supports transferability assessments by readers seeking to apply insights to other contexts.

4. Findings

The analysis of interview data yielded thematic patterns organized around the study's four research questions. This section presents findings sequentially, beginning with practitioner perceptions of AI capabilities and limitations before proceeding to considerations for human–AI collaboration in journalism.

4.1. Irreplaceable Human Competencies in Field Journalism (RQ1)

The first research question asked what human competencies in field journalism practitioners perceive as irreplaceable by artificial intelligence. Analysis revealed three interrelated domains: embodied presence and rapport-building, contextual judgment and meaning-making, and investigative initiative.

4.1.1. Embodied Presence and Rapport-Building

The most consistent theme across practitioner interviews concerned the fundamentally embodied nature of frontline journalism. Participants described interview encounters as relational achievements requiring physical co-presence, emotional attunement, and what P2 termed "the third language" of non-verbal communication—the reporter's gaze, facial expressions, and breath through which "the interviewee and reporter gradually form rapport on the scene."

P2 illustrated this through a 2012 encounter at a victim's funeral during a period of serial killings in Korea: "I encountered the victim's husband in the corridor. Seeing the bewilderment and grief on his face, I began to cry. He approached, and I identified myself as a reporter. We just stood there, saying nothing, only shedding tears. He held my hand and sat down. Then he began to pour out the story he had kept in his heart. I didn't ask a single question. I realized that a reporter's questions don't always have to be words." This account exemplifies journalism's relational core—an achievement dependent not on information exchange but on human presence capable of emotional resonance.

P1 emphasized similar dynamics in immigration coverage: "The desperation of a family being forcibly separated due to immigration enforcement—these are areas AI finds difficult to express. In an interview, people want empathy, they want emotional identification. That's when deeper stories can be drawn out." P6 extended this to visual journalism: "People behave differently when they know a human is behind the camera—someone who sees them, understands their situation, treats them with dignity. That trust opens access that no drone or automated system could achieve."

Embodied presence operates across multiple frontline contexts. P4 described the anchor's role during breaking news: "When a disaster unfolds live, viewers need more than information—they need a human presence that acknowledges the gravity of the situation through voice, expression, and pacing."

4.1.2. Contextual Judgment and Meaning-Making

Beyond the relational dimensions of source interaction, participants consistently identified contextual judgment as a distinctively human competency. This theme encompassed the ability to recognize significance within unfolding events, to connect present occurrences with historical patterns, and to discern meanings that transcend what data alone can reveal.

P1 described this interpretive capacity: "I can grasp the context connecting background, present, and future—why this incident occurred, why this policy emerged, the linkages before and after certain events or policies. AI is insufficient for this kind of contextual sense-making."

P2 elaborated on this creative dimension: "AI basically learns from existing things to analyze large amounts of information quickly and produce results—that's its basic structure. It hasn't yet reached the stage of pursuing novelty on its own. But humans constantly pursue newness—introducing new visual techniques in broadcast news production, constructing new narratives, adopting new graphics. And most importantly, isn't deciding what story to write something only humans can determine?" This emphasis on editorial initiative—the capacity to identify what stories matter—emerged consistently across practitioner accounts as a distinctively human contribution resistant to algorithmic replication.

The temporal dimension of contextual judgment emerged as particularly significant. P4, an anchor with 35 years of broadcasting experience, emphasized journalism's orientation toward the unprecedented: "AI works only with past, textualized old data. But in human memory, there are felt memories. For instance, I saw a trial objectively 30 years ago. The memory I felt then—that's not stored as data anywhere. How can you write that?"

P6, a broadcast journalist specializing in visual production, extended this argument to visual storytelling: "The human element in visual journalism—deciding what angle captures the emotional truth of a scene, what shots will resonate with viewers on an emotional level. AI can generate images, but it cannot stand in a moment and feel what matters. Every frame I capture reflects a decision about what's important, what deserves attention, what the public needs to see. Those decisions require being present, feeling the weight of the moment." This account illustrates how contextual judgment operates not only in textual but also in visual journalism, where framing choices encode interpretive positions about significance and meaning.

4.1.3. Investigative Initiative and Hidden Information

A third dimension of irreplaceable human competency concerned journalism's investigative function—specifically, the capacity to uncover information that powerful actors prefer to conceal. Participants characterized this as requiring not merely analytical capability but initiative, persistence, and the exercise of constitutionally protected press freedoms.

P2 framed this distinction in epistemological terms: "Trust is based on sufficient information. But journalistic information is often not publicly available. Things happening in government, things they want to hide, are not disclosed. AI needs given information; it cannot find information on its own. But humans conduct investigative activities to uncover hidden information through reporting."

P3 elaborated on the constitutional dimensions: "Fact-checking based on evidence is difficult for AI. It's limited to simply arranged, learned information. The freedom of press guaranteed by the constitution—AI technology cannot fulfill that entirely." P7, a newspaper journalist with 30 years of investigative reporting experience, emphasized the relational foundation of investigative work: "Building trust with whistleblowers—getting someone to risk their career, maybe their safety, to tell you something important—that requires human connection. They need to look into your eyes and decide if you're trustworthy. P7 further noted: "Confrontation interviews—where you sit across from someone and ask the hard questions—require reading their reactions in real-time, adjusting your approach, knowing when to press and when to let silence work. AI cannot conduct a confrontation interview." P5, a regional announcer with 10 years of experience, identified source protection as a critical domain requiring human judgment: "Behind-the-scenes stories sometimes struggle to come out into the world even through reporting. Protecting sources in such content—this is something AI cannot replicate."

4.2. Perceived Limitations of Current AI Technologies (RQ2)

The second research question examined practitioners' perceptions of AI limitations in journalism contexts. Analysis identified three primary limitation categories: factual reliability and hallucination, emotional authenticity, and ethical-temporal constraints.

4.2.1. Factual Reliability and Hallucination

Concerns about AI-generated content's factual reliability pervaded practitioner accounts. P1 provided a concrete illustration: "When reading or writing English articles with AI, it often translates "President Trump" as "former President Trump." Since AI is based on previously generated data, there's more data written as 'former president' than data from the Trump second administration. Fact-checking and writing that conveys human emotion—AI is often lacking in these areas."

P1 further cited a specific case demonstrating the real-world consequences of AI hallucination: "Recently, a lawyer named Jo, active in Fort Lee, New Jersey, submitted AI-generated case citations to federal court and was fined $3000. This resulted from submitting

fabricated materials that AI created as if they were real. AI is a tool that helps work quickly, but it doesn't speak only the truth. Because it also lies well, humans must make the final judgment about truth."

P10, an AI-related professional with 11 years in media technology planning, offered an insider perspective: "Current AI systems excel at pattern recognition and content generation based on training data, but they lack mechanisms for real-world verification. The gap between generating plausible text and confirming factual accuracy remains significant."

4.2.2. Emotional Authenticity and Affective Communication

Practitioners consistently questioned AI's capacity for authentic emotional expression. P4 articulated this boundary with precision: "An announcer isn't simply someone who reads a script, but a profession that can move viewers' hearts by putting meaning and emotion into a single breath, a single comma. Also, the ability to judge immediately and respond wittily when unpredictable situations occur—this quick thinking is what differentiates us. Above all, the ability to lead the atmosphere through heartfelt empathy and warm communication is needed, making this an area AI cannot easily replicate."

P8, a terrestrial broadcaster anchor with 15 years of experience, emphasized the communicative significance of human fallibility: "Improvisational responses and the human errors that accompany them—aren't these also elements AI cannot imitate?" The affective dimensions of crisis communication emerged as particularly significant. P4 noted: "In disaster or crisis situations, what matters more than information delivery is 'a voice that transforms fear into stability,' and this is difficult to perform unless you're human."

4.2.3. Ethical Judgment and Responsibility

Beyond technical limitations, participants identified ethical judgment as a domain where AI faces fundamental rather than merely practical constraints. P2 developed this theme extensively:

"An article can become a knife. It can harm someone. If we define ethics as something everyone agrees should be observed—that something is not fixed but something only humans can know. It's not something you can learn and acquire, but a standard that comes from the heart. That standard is acquired through education and social life. In the human process of acquisition, emotion is involved. Beyond simply recognizing 'this shouldn't be done,' we simultaneously experience feelings like guilt and remorse when we do such things. That emotion can function beyond rational thought, like a kind of instinct."

P2 illustrated this through the Itaewon disaster coverage: "During the Itaewon tragedy, I obtained horrific footage from the scene. Broadcasting this footage could raise ratings and might convey the horror of the scene as it was. But humans instinctively feel this isn't ethically right. It's disrespectful to the deceased, disrespectful to the bereaved families. And it could leave trauma for viewers. Though it might help ratings, humans intuitively feel and therefore don't broadcast something that helps no one else."

4.3. Development Implications: From Limitations to Design Principles (RQ3)

The convergence between practitioner experiences and developer perspectives on AI limitations yields concrete implications for future AI journalism development. Rather than pursuing replacement-oriented technologies, participants articulated three evidence-based design principles.

4.3.1. Verification-Centric Architecture

Both practitioners and developers identified reliability as AI journalism's most critical deficiency. P10 acknowledged the fundamental challenge: "The 100% accuracy standard in journalism creates unique constraints for AI deployment. A 99% accuracy rate doesn't exist

in news—even 1% error is unacceptable." Developer participants proposed architectural solutions: embedding uncertainty quantification in AI outputs, automatic flagging of claims requiring verification, and seamless integration with fact-checking workflows. P9 elaborated on the design philosophy: "We're building verification layers into our systems that flag claims requiring human fact-checking, rather than presenting AI-generated content as authoritative. The goal is seamless workflow integration where AI accelerates routine tasks while humans retain editorial control."

4.3.2. Context-Intelligence Systems

Participants envisioned AI's evolution beyond pattern recognition toward contextual understanding. P10 articulated this trajectory: "Imagine AI systems that have learned not just facts but the histories behind human relationships—who has conflicts with whom, what sensitivities exist in particular communities, what historical traumas inform current responses." Rather than replacing human contextual judgment, such systems would amplify it by providing journalists with synthesized background intelligence. P9 offered a concrete example: "The system could brief journalists before interviews, flagging 'this source lost a family member in a similar incident five years ago' or 'this community has a history of distrust toward media due to past misrepresentation.'"

4.3.3. Workflow Integration over Function Replacement

Practitioners identified adoption barriers stemming from AI tools' incompatibility with journalistic workflows. P2 noted: "Reporters in the field, pressed for time daily, have relatively low receptivity to new technology and environments. AI tools that require workflow transformation face resistance." Developer participants confirmed this insight. P10 observed: "Systems designed to replace journalists encounter resistance; systems designed to augment journalistic capabilities find adoption." The practical implication is participatory design: involving journalists in AI tool development from inception, prioritizing tools that fit existing workflows, and measuring success through journalist time savings rather than labor displacement.

4.4. Collaborative Configuration: A Three-Tier Model (RQ4)

Analysis of practitioner accounts revealed a concrete three-tier model for human–AI collaboration in journalism. This model specifies functional allocation across computational, editorial, and ethical tiers.

4.4.1. Tier 1: Computational Labor (AI-Dominant)

Participants consistently identified tasks appropriate for AI autonomy: data aggregation, transcription, translation, background research, and routine content generation from structured data. P7 described appropriate delegation: "AI should handle routine single-paragraph articles and generate images for content that cannot be expressed otherwise, with clear disclosure." The distinguishing feature of Tier 1 tasks is their algorithmic specifiability—tasks with clear inputs, defined processes, and objectively verifiable outputs. P9 noted AI's comparative advantage: "In areas like weather and sports game results—where there's data and fixed formats—AI can be quite usefully employed."

4.4.2. Tier 2: Editorial Judgment (Human-Dominant, AI-Supported)

The middle tier encompasses tasks requiring interpretation, contextualization, and news judgment—distinctively human competencies that AI can support but not execute. P2 articulated the principle: "AI can reduce considerable time in writing in-depth articles through material search and data analysis. But the work of interpreting AI's results and assigning meaning is purely work that humans must do." This tier includes story

selection, angle determination, source evaluation, narrative construction, and contextual framing. AI's role is augmentative: providing background research, suggesting story angles, identifying potential sources, and generating initial drafts for human revision. P4 described the division: "Repetitive news bulletins can be left to AI, while announcers focus on advanced areas like analysis and interviews."

4.4.3. Tier 3: Ethical Accountability (Exclusively Human)

The third tier comprises decisions where AI involvement is categorically inappropriate: ethical dilemmas in coverage, source protection decisions, harm assessment, and accountability for published content. P2's Itaewon disaster example illustrated this boundary: the decision not to broadcast disturbing footage required integrating professional norms, situational assessment, anticipated consequences, and moral responsibility—a synthesis AI cannot replicate. Participants emphasized that ethical responsibility is non-delegable. P3 stated: "Human journalists must use AI technically, but fact reporting through field coverage must remain work that only human journalists can do." The collaborative model at this tier excludes AI entirely from decision-making while potentially using AI for information provision. The critical principle is that moral responsibility and legal accountability rest with human journalists, not algorithmic systems.

Table 3 summarizes the three-tier collaborative model with example tasks, role allocation, and oversight mechanisms.

Table 3. Three-tier human–AI collaborative model for journalism *.

Tier	Domain	Role Allocation	Example Tasks	Human Oversight
1	Computational Labor	AI-Dominant (Human oversight)	• Data aggregation • Transcription • Translation • Background research • Routine content generation (weather, sports scores) • Image/video tagging	• Random sampling • Periodic accuracy audits • Escalation protocols
2	Editorial Judgment	Human-Dominant (AI-Supported)	• Story selection • Angle determination • Source evaluation • Narrative construction • Contextual framing • Draft generation for human revision	• Human decision-making authority • AI provides research and suggestions only • All outputs human-reviewed
3	Ethical Accountability	Exclusively Human (No AI involvement)	• Ethical dilemmas in coverage • Source protection decisions • Harm assessment • Content publication decisions • Legal accountability	• No AI involvement in decision-making • AI may flag content for human review • Moral responsibility non-delegable

* Tier boundaries are context-dependent and may shift as AI capabilities evolve. Human oversight requirements increase with the ethical stakes of each domain.

5. Discussion

The findings of this study illuminate the complex terrain of human–AI relations in journalism, revealing patterns that both confirm and extend existing theoretical frameworks. This section interprets the empirical results through the integrated lens of human–machine communication theory, field theory, and the complementarity framework, while identifying contributions to ongoing scholarly conversations.

5.1. Theoretical Implications

5.1.1. Reconceptualizing Human–Machine Communication in Journalism

The practitioner accounts offer empirical grounding for human–machine communication scholarship. Guzman and Lewis (2020) proposed that human–machine relationships require attention to functional, relational, and metaphysical dimensions. The present findings suggest that field journalism activates all three simultaneously. Functionally, participants acknowledged AI's utility for discrete tasks while demarcating boundaries around contextual judgment. P2's "third language" of non-verbal communication—gaze, expression, breath—points toward requirements current AI architectures cannot satisfy due to computational systems' disembodied nature. Relationally, journalism's achievements depend upon recognition of shared humanity. P1's observation that "people want empathy" indicates interview encounters operate as relational accomplishments requiring mutual recognition. Metaphysically, practitioner accounts repeatedly invoked responsibility, conscience, and moral intuition—presupposing agency forms that AI systems lack. If ethical judgment requires affective engagement with moral stakes, AI faces constraints that improved training data cannot overcome.

5.1.2. Field Theory and Professional Identity

Bourdieu's field theory illuminates how practitioner resistance reflects identity preservation and capital defense. The journalistic field operates through cultural capital (professional knowledge), social capital (source networks), and symbolic capital (institutional recognition) (Benson, 2006). AI threatens each distinctly. Cultural capital faces devaluation when computational systems perform tasks previously requiring expertise, though participants identified higher-order competencies—contextual interpretation and ethical discernment—as resistant to commoditization. Social capital, particularly source relationships, emerged as most AI-resistant. P2's crematorium encounter illustrates that trust enabling sensitive information sharing cannot be algorithmically generated. Symbolic capital faces complex implications, with participants expressing concern that AI-generated content could undermine journalism's credibility.

5.1.3. Complementarity as Organizing Principle

The complementarity framework proposed by Dodds et al. (2026a) finds strong empirical support in practitioner accounts. Rather than viewing human and artificial intelligence as competitors for the same functional territory, participants consistently articulated visions of differentiated contribution. This finding resonates with Linden's (2017) observation that journalists' ideological commitment to their professional role has historically functioned as a mitigating force against displacement, suggesting that complementarity is not merely a theoretical aspiration but an empirically grounded professional disposition.

5.2. Empirical Contributions

By centering frontline journalism—embodied reporting, source encounters, on-scene coverage—this study addresses an underexplored domain. Much existing scholarship has examined newsroom automation or algorithmic content generation. The present study's attention to "where journalism happens"—crematoriums, courtrooms, disaster sites—reveals AI limitations specific to field-based dimensions, foregrounding human capacities most resistant to automation: physical presence, emotional attunement, and relational improvisation.

6. Considerations for Human–AI Complementarity in Journalism

Drawing from the empirical findings and theoretical analysis, this section proposes a framework for conceptualizing and implementing human–AI complementarity in journalism practice. The framework addresses three stakeholder domains: AI technologists, journalists, and collaborative systems.

6.1. Considerations for AI Technologists

Given journalism's stringent accuracy requirements, AI systems must incorporate robust verification mechanisms rather than presenting generated content as authoritative. P1's observation about AI "lying well" and P10's acknowledgment that "100% accuracy" remains unachievable suggest that transparency about uncertainty should be designed into system interfaces. Practically, this might include confidence indicators for AI-generated content, automatic flagging of claims requiring verification, and seamless integration with fact-checking workflows.

The adoption barriers identified by P2—time pressure and low technology receptivity among experienced journalists—indicate that AI tools must integrate with existing professional routines rather than demanding workflow transformation. Successful deployment requires understanding journalism's temporal rhythms, organizational structures, and cultural norms.

6.2. Considerations for Journalists

While maintaining distinctively human competencies, journalists also benefit from understanding AI capabilities and limitations. P8's call for "AI utilization and data literacy education" reflects recognition that effective human–AI collaboration requires informed human partners. Journalists who understand what AI can and cannot do are better positioned to deploy it effectively while maintaining appropriate skepticism.

The institutional concerns raised by participants—copyright issues, regulatory gaps, potential for misuse—suggest that journalists have roles to play beyond individual practice adaptation. P4's observation that "legal and institutional standards are urgently needed" points toward collective action domains: advocating for appropriate regulation, participating in standards development, and ensuring that professional voice shapes AI journalism's trajectory.

6.3. Considerations for Collaborative Systems

The findings suggest principles for designing human–AI collaborative systems in journalism contexts. Effective collaboration requires a clear delineation of human and AI responsibilities. The task domains identified in this study—AI for data processing, routine generation, and computational analysis; humans for source relationships, ethical judgment, and interpretive work—provide a starting framework. However, specific implementations will require context-sensitive boundary negotiation responsive to organizational needs and professional norms.

Across collaborative configurations, human journalists should retain authority over consequential decisions. This principle reflects both the ethical considerations articulated by participants—AI cannot bear moral responsibility—and practical reliability concerns.

Collaborative systems should maintain clear attribution of human and AI contributions, enabling accountability when errors occur. P7's suggestion that AI-generated content should carry explicit disclosure reflects a broader principle: audiences and colleagues should be able to identify AI involvement in journalistic products.

7. Conclusions

This study offers several contributions to AI journalism scholarship. Theoretically, the research demonstrates the value of integrating human–machine communication theory, field theory, and the complementarity framework for understanding human–AI relations in journalism. Empirically, the multi-stakeholder design—incorporating journalists, anchors, and AI developers—provides perspectives unavailable in prior single-stakeholder research. The convergence between practitioner and developer assessments regarding AI limitations suggests that identified boundaries reflect genuine constraints rather than professional defensiveness. Methodologically, the study's emphasis on experiential accounts yields findings grounded in concrete professional practice, illuminating the phenomenological dimensions of journalistic work that abstracted competency frameworks often miss.

The findings point toward what might be termed a "journalistic algorithm"—not an AI system, but a conceptual framework specifying the distinctively human operations that constitute journalism's irreducible core. This journalistic algorithm encompasses various features: establishing rapport through embodied presence; earning trust through relational continuity; exercising judgment through contextual interpretation; bearing responsibility through moral agency; and pursuing truth through investigative initiative. These operations resist algorithmic specification not because they are mysterious but because they depend upon forms of human being—embodiment, sociality, moral agency, and temporal experience—that artificial systems do not possess. The journalistic algorithm thus functions as both a descriptive framework (identifying what journalists distinctively do) and a normative guide (indicating where human involvement must be preserved).

Crucially, this journalistic algorithm is not enacted in isolation but in relation to audiences whose trust undergirds journalism's democratic legitimacy. Whether AI-mediated content can sustain the human bond of credibility that readers extend to journalism remains an open and consequential question—one that future research must address empirically. The present study's findings suggest that practitioners themselves perceive this bond as contingent on human authorship and moral accountability, pointing toward a public dimension of human–AI complementarity that scholarship has yet to fully theorize.

8. Limitations and Future Directions

Several limitations warrant acknowledgment. First, the sample's composition—weighted toward broadcast journalism (70%) with limited representation from print (10%) and digital-native (0%) contexts—may limit generalizability to other journalism domains where AI integration patterns differ. The inclusion of only two AI developers, while providing valuable triangulation, represents a limited window into technological development perspectives; future research might benefit from larger developer samples or ethnographic observation of AI tool development processes. Second, the sample, while strategically composed for depth, remains modest in size (n = 10) and geographically concentrated in the Korean media context. The perspectives of journalists in different national contexts—particularly those in resource-constrained media environments or those operating under different regulatory frameworks—might reveal different patterns of AI adoption and resistance.

Future research might productively extend this investigation in several directions. Longitudinal studies could track how human–AI boundaries evolve as technology advances and professional norms adapt. Comparative research across national contexts could identify how different journalism cultures shape AI integration patterns. Ethnographic approaches could examine human–AI collaboration in situ, observing how practitioners actually deploy AI tools in daily work. Experimental designs could test specific complementarity configurations, assessing their effects on journalism quality and practitioner experience.

https://doi.org/10.3390/journalmedia7020082

The embodied encounters, relational achievements, contextual judgments, and moral responsibilities that constitute field journalism depend upon forms of human presence and agency that AI cannot replicate. The future of journalism likely lies not in choosing between human and artificial intelligence but in configuring their complementarity wisely, preserving what is distinctively valuable in human journalism while leveraging what AI genuinely enables.

Funding: This research received no external funding.

Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Public Institutional Review Board (protocol code P01-202509-01-085, date of approval: 23 September 2025).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The data presented in this study are not publicly available due to privacy and ethical restrictions, as the data contain sensitive information from interview participants.

Acknowledgments: The author thanks all participants for their time and insights and acknowledges colleagues who provided feedback on earlier drafts of this manuscript.

Conflicts of Interest: The author declares no conflicts of interest.

Abbreviations

The following abbreviations are used in this manuscript:

AI	Artificial Intelligence
HMC	Human–Machine Communication
IRB	Institutional Review Board

Appendix A

Semi-Structured Interview Protocol for Frontline Journalism Practitioners and AI Developers

The semi-structured interview protocol addressed six thematic domains:

Domain 1: Task Boundaries

What journalist tasks do you believe AI technology can never replace?

Why do you continue to perform these tasks personally despite AI advancements?

Domain 2: Ethics and Responsibility

Why is ethical judgment important in journalism?

What ethical or responsible decisions are difficult for AI to make?

Domain 3: Creativity and Emotion

What creative aspects of article writing do you feel only you can accomplish?

How would you explain the importance of emotional empathy and face-to-face interaction that you demonstrate, unlike AI?

Domain 4: Journalistic Values

What meaning do truthfulness and credibility hold in journalism?

How do you strive to uphold these values? What differences do you see compared to AI?

Domain 5: Technology Acceptance

What factors have influenced your decision to utilize or exclude AI?

What relationship should AI and human journalists have in journalism going forward?

Domain 6: Future Outlook

What changes do you anticipate as AI becomes more deeply integrated into journalism?

What preparations or concerns do you have for the AI era?

Appendix B

Thematic Coding Framework for Frontline Journalism and AI Complementarity Analysis (Table A1).

Table A1. Thematic coding structure.

Theme	Subtheme	Definition	Example Codes
Embodied Presence	Physical co-presence	Requirement of bodily presence for journalistic tasks	"being there," "face-to-face," "on-scene"
	Non-verbal communication	Communication through gaze, expression, gesture	"third language," "eye contact," "silence"
	Rapport formation	Building trust through embodied interaction	"communion," "rapport," "connection"
Contextual Judgment	Meaning-making	Interpretation beyond data	"context," "significance," "why"
	Temporal connection	Linking past, present, future	"background," "history," "precedent"
	Novelty recognition	Identifying the unprecedented	"new," "unexpected," "unprecedented"
Ethical Responsibility	Moral intuition	Felt sense of right/wrong	"instinct," "conscience," "gut"
	Harm consideration	Weighing potential damages	"consequences," "impact," "harm"
	Accountability	Personal responsibility for decisions	"responsibility," "ownership," "accountability"
AI Limitations	Factual unreliability	Hallucination, inaccuracy	"fabrication," "error," "verification"
	Emotional absence	Lack of genuine affect	"mechanical," "cold," "artificial"
	Initiative deficit	Inability to self-direct inquiry	"given," "programmed," "reactive"
Complementarity	Task division	Allocation of human/AI functions	"routine," "complex," "division"
	Augmentation	AI enhancing human capacity	"assist," "support," "tool"
	Boundary maintenance	Preserving human authority	"final say," "human judgment," "oversight"

References

Al Masum Molla, M., & Ahsan, M. M. (2025). Artificial intelligence and journalism: A systematic bibliometric and thematic analysis of global research. *Computers in Human Behavior Reports*, *20*, 100830. [CrossRef]

Benson, R. (2006). News media as a "journalistic field": What Bourdieu adds to new institutionalism, and vice versa. *Political Communication*, *23*(2), 187–202. [CrossRef]

Benson, R., & Neveu, E. (Eds.). (2005). *Bourdieu and the journalistic field*. Polity Press.

Borges-Rey, E. (2016). Unravelling data journalism: A study of data journalism practice in British newsrooms. *Journalism Practice*, *10*(7), 833–843. [CrossRef]

Bourdieu, P. (1998). *On television*. The New Press.

Braun, V., & Clarke, V. (2019). Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health*, *11*(4), 589–597. [CrossRef]

Braun, V., & Clarke, V. (2021). *Thematic analysis: A practical guide*. SAGE Publications.

Broussard, M., Diakopoulos, N., Guzman, A. L., Abebe, R., Dupagne, M., & Chuan, C. H. (2019). Artificial intelligence and journalism. *Journalism & Mass Communication Quarterly*, *96*(3), 673–695. [CrossRef]

Calvo-Rubio, L. M., & Ufarte-Ruiz, M. J. (2021). Artificial intelligence and journalism: Systematic review of scientific production in Web of Science and Scopus (2008–2019). *Communication & Society*, *34*(2), 159–176. [CrossRef]

Canavilhas, J. (2022). Artificial intelligence and journalism: Current situation and expectations in the Portuguese sports media. *Journalism and Media*, *3*(3), 510–520. [CrossRef]

Carlson, M. (2018). The robotic reporter: Automated journalism and the redefinition of labor, compositional forms, and journalistic authority. In *Journalism in an era of big data* (pp. 108–123). Routledge.

Clerwall, C. (2017). Enter the robot journalist: Users' perceptions of automated content. In *The future of journalism: In an age of digital media and economic uncertainty* (pp. 165–177). Routledge.

Cools, H., & Diakopoulos, N. (2024). Uses of generative AI in the newsroom: Mapping journalists' perceptions of perils and possibilities. *Journalism Practice*, *20*(3), 878–896. [CrossRef]

de-Lima-Santos, M. F., & Ceron, W. (2021). Artificial intelligence in news media: Current perceptions and future outlook. *Journalism and Media*, *3*(1), 13–26. [CrossRef]

Dodds, T., Ngai Yeung, W., Mellado, C., & De Lima-Santos, M. F. (2026a). On controlled change: Generative AI's impact on professional authority in journalism. *Journalism Studies*, 1–18. [CrossRef]

Dodds, T., Zamith, R., & Lewis, S. C. (2026b). The AI turn in journalism: Disruption, adaptation, and democratic futures. *Journalism*, *27*(3), 530–544. [CrossRef]

Dörr, K. N. (2016). Mapping the field of algorithmic journalism. *Digital Journalism*, *4*(6), 700–722. [CrossRef]

Gondwe, G. (2025). Artificial intelligence, journalism, and the Ubuntu robot in Sub-Saharan Africa: Towards a normative framework. *Digital Journalism*, *13*(4), 826–844. [CrossRef]

Graefe, A. (2016). *Guide to automated journalism*. Tow Center for Digital Journalism, Columbia University.

Graefe, A., & Bohlken, N. (2020). Automated journalism: A meta-analysis of readers' perceptions of human-written in comparison to automated news. *Media and Communication*, *8*(3), 50–59. [CrossRef]

Guest, G., Bunce, A., & Johnson, L. (2006). How many interviews are enough? An experiment with data saturation and variability. *Field Methods*, *18*(1), 59–82. [CrossRef]

Guzman, A. L. (2018). What is human-machine communication, anyway? In A. L. Guzman (Ed.), *Human-machine communication: Rethinking communication, technology, and ourselves* (pp. 1–28). Peter Lang.

Guzman, A. L., & Lewis, S. C. (2020). Artificial intelligence and communication: A human-machine communication research agenda. *New Media & Society*, *22*(1), 70–86. [CrossRef]

Hennink, M. M., Kaiser, B. N., & Marconi, V. C. (2017). Code saturation versus meaning saturation: How many interviews are enough? *Qualitative Health Research*, *27*(4), 591–608. [CrossRef]

Kosterich, A. (2020). Managing news nerds: Strategizing about institutional change in the news industry. *Journal of Media Business Studies*, *17*, 51–68. [CrossRef]

Lewis, S. C., Guzman, A. L., & Schmidt, T. R. (2019). Automation, journalism, and human-machine communication: Rethinking roles and relationships of humans and machines in news. *Digital Journalism*, *7*(4), 409–427. [CrossRef]

Lindblom, T., Lindell, J., & Gidlund, K. (2024). Digitalizing the journalistic field: Journalists' views on changes in journalistic autonomy, capital and habitus. *Digital Journalism*, *12*(6), 894–913. [CrossRef]

Linden, C.-G. (2017). Decades of automation in the newsroom: Why are there still so many jobs in journalism? *Digital Journalism*, *5*(2), 123–140. [CrossRef]

Lischka, J. A., Schaetz, N., & Oltersdorf, A. L. (2023). Editorial technologists as engineers of journalism's future: Exploring the professional community of computational journalism. *Digital Journalism*, *11*(6), 1026–1044. [CrossRef]

Londoño-Proaño, A. C., & Buele, J. (2025). Can artificial intelligence replace journalists? A theoretical approach to AI-journalism complementarity. *Frontiers in Communication*, *10*, 1537146. [CrossRef]

Maares, P., & Hanusch, F. (2020). Exploring the boundaries of journalism: Instagram micro-bloggers in the twilight zone of lifestyle journalism. *Journalism*, *21*(2), 262–278. [CrossRef]

Munoriyarwa, A., & Chiumbu, S. (2024). Artificial intelligence skepticism in news production: The case of South Africa's mainstream news organizations. In *Global journalism in comparative perspective* (pp. 117–131). Routledge.

Newman, N. (2026). *Journalism and technology trends and predictions 2026*. Reuters Institute for the Study of Journalism.

Örnebring, H. (2010). Technology and journalism-as-labour: Historical perspectives. *Journalism*, *11*(1), 57–74. [CrossRef]

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (4th ed.). SAGE Publications.

Porlezza, C., & Schapals, A. K. (2024). AI ethics in journalism (studies): An evolving field between research and practice. *Emerging Media*, *2*(3), 356–370. [CrossRef]

Schultz, I. (2007). The journalistic gut feeling: Journalistic doxa, news habitus and orthodox news values. *Journalism Practice*, *1*(2), 190–207. [CrossRef]

Szeman, I. (2000). Bourdieu on television [Review of the book On television, by P. Bourdieu]. *Canadian Journal of Communication*, *25*(1), 103–107. [CrossRef]

Thurman, N., Lewis, S. C., & Kunert, J. (2019). Algorithms, automation, and news. *Digital Journalism*, *7*(8), 980–992. [CrossRef]

Túñez-López, J. M., Fieiras-Ceide, C., & Vaz-Álvarez, M. (2021). Impact of artificial intelligence on journalism: Transformations in the company, products, contents and professional profile. *Communication & Society*, *34*(1), 177–193. [CrossRef]

Wu, S. (2024). Journalists as individual users of artificial intelligence: Examining journalists' "value-motivated use" of ChatGPT and other AI tools within and without the newsroom. *Journalism*, *27*(2), 388–406. [CrossRef]

Wu, S., Tandoc, E. C., Jr., & Salmon, C. T. (2019). Journalism reconfigured: Assessing human–machine relations and the autonomous power of automation in news production. *Journalism Studies*, *20*(10), 1440–1457. [CrossRef]

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.