Feedback International Journal of Communication Vol. 3 No. 2, 2026
ISSN (online): 3046-9465
DOI: https://doi.org/10.62569/fijc.v3i2.274
Received: May 2026/ Revised: June 2026/ Accepted: June 2026

Feedback International Journal of Communication
https://ejournal.agungmediapublisher.com/index.php/fijc

Virtual Reality as a Strategic Communication Medium for Enhancing Public Understanding of Upstream Oil and Gas Operations

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Abstract. The increasing complexity of upstream oil and gas operations presents significant communication challenges in improving public understanding and stakeholder engagement. Conventional communication approaches, such as brochures, presentations, and public meetings, often fail to effectively convey technical information and environmental management practices to nontechnical audiences. Virtual Reality (VR) has emerged as an innovative communication technology capable of providing immersive and interactive experiences that enhance public comprehension of complex industrial activities. This study aims to examine the strategic role of VR as a communication medium for enhancing public understanding of upstream oil and gas operations. A qualitative research approach was employed using a literature review method. Relevant literature published between 2015 and 2025 was collected from Scopus, ScienceDirect, IEEE Xplore, SpringerLink, Taylor & Francis Online, Emerald Insight, and Google Scholar. The selected publications were analyzed using thematic analysis to identify recurring patterns regarding the communication functions, opportunities, and implementation challenges of VR. The findings reveal three major themes. First, VR enhances public understanding by transforming complex technical information into immersive communication experiences that facilitate experiential learning. Second, VR strengthens stakeholder engagement and public trust by promoting transparency, reducing information asymmetry, and supporting interactive communication between industrial organizations and surrounding communities. Third, successful VR implementation requires strategic investment, technological infrastructure, institutional readiness, and interdisciplinary collaboration despite its considerable long term communication benefits.

Keywords: Virtual Reality; Strategic Communication; Public Understanding; Stakeholder Engagement; Upstream Oil and Gas; Immersive Communication

1. Introduction

The upstream oil and gas industry remains one of the most strategic sectors supporting global energy security and economic development (Dongo & Relvas, 2025;

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Mohammadpoor & Torabi, 2020; Sircar et al., 2021). In Indonesia (Nordin et al., 2023; Rahayu et al., 2025; Subadi, 2021), upstream oil and gas activities contribute significantly to national energy production, with approximately 60 to 70 percent of crude oil and natural gas output originating from offshore operations. These operations involve complex exploration, drilling, production, and environmental management processes that are rarely accessible to the public due to stringent safety regulations, geographical constraints, and operational risks. Consequently, public understanding of upstream oil and gas activities remains limited, despite their direct contribution to national development and energy sustainability. This knowledge gap frequently results in misconceptions regarding industrial operations, environmental risks, and corporate responsibilities, thereby influencing public perception and acceptance of oil and gas projects (Morgunova & Shaton, 2022).

Stella Emeka-Okoli et al. (2024) argues that effective communication has therefore become a critical component of sustainable upstream oil and gas operations. Contemporary industrial communication extends beyond merely disseminating technical information; it seeks to establish transparency, foster trust, and encourage meaningful stakeholder engagement throughout the project lifecycle. Communities increasingly expect accessible, credible, and interactive information regarding industrial activities that may affect their environment and livelihoods (Zara et al., 2023). However, conventional communication approaches, including public meetings, brochures, presentations, videos, and informational campaigns, often struggle to explain highly technical processes in ways that are understandable to nontechnical audiences. These communication methods generally rely on one way information delivery, providing limited opportunities for experiential learning and interactive engagement. As a result, they frequently fail to reduce uncertainty or build sufficient public confidence regarding upstream oil and gas operations.

Recent advances in digital communication technologies have created new opportunities to overcome these limitations. Among these innovations, Virtual Reality (VR) has emerged as one of the most promising immersive communication technologies capable of transforming the way complex information is delivered. VR enables users to experience simulated three dimensional environments that closely resemble real operational settings, allowing them to observe, interact with, and explore industrial processes without physical presence at hazardous locations (Dos Santos et al., 2012; Muda et al., 2024). Unlike conventional visualization techniques, VR integrates immersive visual experiences, spatial interaction, and real time user engagement, thereby facilitating experiential learning that enhances knowledge retention and comprehension. The increasing accessibility of VR technology has encouraged its adoption across various sectors, including healthcare, education, manufacturing, tourism, architecture, and industrial safety training.

Numerous previous studies have demonstrated the effectiveness of VR in improving technical education, professional training, operational simulations, and safety preparedness (Duncan, 2015; Kokkinos et al., 2022). Immersive simulations have been shown to enhance learners' cognitive understanding, decision making abilities, procedural memory, and situational awareness more effectively than traditional instructional methods. In industrial contexts, VR has successfully supported operator training, equipment maintenance, emergency response exercises, and engineering visualization while simultaneously reducing operational costs and safety risks. These findings indicate that VR possesses substantial educational and technological value. Nevertheless, the

majority of existing studies primarily position VR as a learning or training technology rather than as a strategic communication medium designed to facilitate dialogue between industries and external stakeholders, particularly surrounding communities.

Despite the growing body of literature on VR applications, limited scholarly attention has been devoted to examining its potential role in public communication within the upstream oil and gas industry. Existing research predominantly emphasizes engineering performance, operational efficiency, workforce competency, and immersive training environments, whereas investigations concerning public understanding, stakeholder engagement, and communication effectiveness remain relatively scarce. Furthermore, studies discussing community communication often continue to focus on conventional outreach strategies without considering how immersive technologies may transform public participation and social acceptance. This gap suggests that the communication dimension of VR has not yet been sufficiently conceptualized within the context of upstream oil and gas operations, particularly as an instrument for bridging knowledge disparities between industrial organizations and the communities they serve.

From the perspective of communication theory, VR offers unique characteristics that distinguish it from traditional communication media (Liao, 2024; Torro & Pirkkalainen, 2023). Its immersive, interactive, and experiential nature enables audiences not only to receive information but also to actively experience operational environments and observe complex industrial processes from a first person perspective. Such experiences have the potential to increase cognitive understanding, reduce psychological distance, strengthen message credibility, and encourage greater stakeholder involvement. By enabling virtual access to offshore facilities, drilling platforms, production systems, and environmental management practices, VR can transform abstract technical explanations into concrete experiences that are more easily understood by diverse audiences. Consequently, VR should be viewed not merely as an emerging digital technology but also as a strategic communication platform capable of strengthening transparency, public trust, and long term relationships between industry and society.

Based on these considerations, this study aims to critically examine the role of Virtual Reality as a strategic communication medium for enhancing public understanding of upstream oil and gas operations through a comprehensive literature review. Specifically, this study synthesizes previous research concerning VR applications, identifies its communication advantages and implementation challenges, and explores its potential contribution to improving public engagement within the upstream oil and gas sector. By integrating perspectives from communication studies, immersive media, and industrial communication, this review seeks to extend the existing literature beyond technological applications and reposition Virtual Reality as an innovative communication strategy that supports more transparent, participatory, and socially sustainable industrial development.

2. Method

This study employed a qualitative research approach using a literature review as the primary research method to explore the role of Virtual Reality (VR) as a strategic communication medium for enhancing public understanding of upstream oil and gas operations (Aspers & Corte, 2019; Busetto et al., 2020; Snyder, 2019; Xiao & Watson, 2019). A qualitative approach was considered appropriate because the objective of this study was not to measure causal relationships or test hypotheses but rather to develop an in depth understanding of how VR has been conceptualized and implemented within the

context of industrial communication. This approach enabled the researchers to interpret previous findings, identify emerging communication themes, and examine the opportunities and challenges associated with the adoption of VR in facilitating public engagement within the upstream oil and gas sector.

The data used in this study consisted exclusively of secondary data obtained from peer reviewed journal articles, books, conference proceedings, and research reports relevant to Virtual Reality, strategic communication, public engagement, and the upstream oil and gas industry. Literature was collected from internationally recognized academic databases, including Scopus, ScienceDirect, IEEE Xplore, SpringerLink, Taylor & Francis Online, Emerald Insight, and Google Scholar. To ensure the relevance and quality of the reviewed literature, the search focused on publications written in English and published between 2015 and 2025. The keywords used during the literature search included *Virtual Reality, immersive communication, strategic communication, public communication, stakeholder engagement, public understanding, oil and gas industry, and upstream oil and gas,* either individually or in combination using Boolean operators.

The selection of literature followed several inclusion criteria to ensure the credibility of the analysis. Publications were included if they discussed the application of Virtual Reality in communication, education, industrial training, stakeholder engagement, or public participation and provided sufficient theoretical or empirical evidence relevant to the objectives of this study. Conversely, duplicate publications, opinion papers, editorials, book reviews, and studies with limited relevance to communication or Virtual Reality applications were excluded from the analysis. Following the screening process, the selected publications were carefully reviewed to identify concepts, findings, and arguments related to the communication potential of VR within industrial environments, particularly upstream oil and gas operations.

Data analysis was conducted using qualitative thematic analysis (Braun & Clarke, 2006; Naeem et al., 2023). The researchers repeatedly examined the selected literature to identify recurring concepts, similarities, differences, and emerging patterns regarding the strategic role of VR in industrial communication. The extracted findings were subsequently organized into several thematic categories, including immersive communication experiences, enhancement of public understanding, stakeholder engagement, communication effectiveness, technological challenges, implementation barriers, and future development opportunities. Rather than merely summarizing previous studies, the analysis emphasized critical interpretation by comparing findings across the literature and identifying conceptual relationships that explain how VR contributes to more effective public communication.

This study applied the principles of credibility, dependability, and confirmability commonly adopted in qualitative research. Credibility was strengthened through the use of diverse and authoritative academic sources from multiple databases, while dependability was maintained by applying consistent literature selection procedures and analytical criteria throughout the review process. Confirmability was achieved by ensuring that all interpretations and conclusions were grounded in evidence derived from the reviewed literature rather than the researchers' personal assumptions. Through this qualitative literature review, the study provides a comprehensive conceptual understanding of Virtual Reality as a strategic communication medium capable of improving transparency, public understanding, and stakeholder engagement in upstream oil and gas operations.

3. Results and Discussion

The qualitative analysis of the selected literature reveals that Virtual Reality (VR) has evolved beyond its conventional function as an educational or training technology and increasingly serves as a strategic communication medium in industrial contexts. Across the reviewed studies, VR consistently demonstrates its ability to transform complex technical information into immersive experiences that are more accessible, engaging, and meaningful for diverse audiences. Rather than simply delivering information, VR facilitates experiential communication by enabling users to actively explore virtual environments, observe operational processes, and interact with digital representations of industrial activities. These characteristics position VR as an emerging communication platform capable of supporting greater transparency and improving public comprehension of technically sophisticated industries such as upstream oil and gas.

The thematic analysis further identified three major findings that characterize the strategic role of VR in enhancing public understanding of upstream oil and gas operations. First, VR improves public understanding by providing immersive communication experiences that simplify complex technical information. Second, VR strengthens stakeholder engagement and promotes public trust by facilitating more transparent and interactive communication between industry and society. Third, the successful implementation of VR depends on organizational readiness, technological infrastructure, and long term strategic investment. Together, these findings demonstrate that VR should be viewed not merely as an innovative digital technology but as a strategic communication medium capable of supporting more inclusive, participatory, and sustainable industrial communication.

3.1. Virtual Reality Enhances Public Understanding through Immersive Communication Experiences

Virtual Reality (VR) has substantial potential to enhance public understanding of upstream oil and gas operations by transforming complex technical information into immersive communication experiences. The reviewed literature consistently demonstrates that one of the primary challenges in communicating upstream oil and gas activities lies in the highly technical nature of exploration, drilling, production, and environmental management processes. These activities are generally inaccessible to the public because they are conducted in offshore locations or high risk industrial environments where strict operational and safety regulations limit public access. Consequently, conventional communication methods, such as brochures, presentations, videos, and public seminars, often fail to convey the complexity of industrial operations in a manner that is easily understood by nontechnical audiences. VR addresses this limitation by providing a virtual environment in which users can experience industrial processes directly, allowing them to observe operational activities without being physically present at the site. This immersive approach transforms abstract technical explanations into realistic experiences that are easier to interpret, thereby reducing cognitive barriers that commonly arise in traditional communication.

Another important finding emerging from the reviewed studies is that VR facilitates experiential learning, which significantly improves knowledge acquisition and comprehension. Unlike passive communication media that require audiences to interpret information solely through reading or listening, VR enables individuals to actively interact with simulated operational environments. Users can virtually navigate offshore platforms, inspect drilling equipment, observe production facilities, and examine environmental

protection systems from multiple perspectives. Such interactions encourage active exploration rather than passive observation, allowing users to construct knowledge through direct experience. Educational psychology suggests that experiential learning enhances cognitive processing because individuals retain information more effectively when they participate in realistic situations rather than merely receiving verbal explanations. Consequently, VR supports deeper understanding of industrial processes while simultaneously increasing users' confidence in interpreting complex engineering information.

The literature further reveals that immersive communication contributes to greater public awareness of operational safety and environmental sustainability. Public concern regarding upstream oil and gas operations frequently centers on issues such as offshore accidents, oil spills, environmental degradation, and occupational safety. However, conventional communication strategies often provide limited opportunities for communities to observe how companies implement preventive measures and emergency response procedures. Through VR simulations, users can virtually experience safety protocols, emergency evacuation procedures, pollution prevention systems, waste management practices, and environmental monitoring activities that are difficult to demonstrate through printed materials or conventional audiovisual presentations. Such visualization not only improves technical understanding but also enhances transparency by allowing communities to observe the operational standards adopted by the industry. As a result, immersive communication reduces uncertainty, clarifies misconceptions, and strengthens public confidence regarding industrial safety and environmental responsibility.

From a strategic communication perspective, the reviewed literature suggests that VR fundamentally changes the nature of communication between industrial organizations and the public. Traditional communication models generally position communities as passive recipients of information, whereas VR encourages audiences to become active participants in the communication process. The immersive characteristics of VR enable users to explore industrial environments independently, examine operational processes according to their own interests, and develop personal interpretations based on direct virtual experiences. This interactive communication process aligns with contemporary communication theories that emphasize audience participation, engagement, and meaning construction rather than one way information transmission. Therefore, VR should not merely be viewed as a technological innovation but as a communication platform that supports transparency, dialogue, and collaborative understanding between industrial organizations and stakeholders. Such communication characteristics are particularly valuable in industries where technical complexity frequently creates information asymmetry between experts and the general public.

The synthesis of previous studies demonstrates that the communication value of VR extends far beyond its visualization capabilities. Rather than functioning solely as a digital representation of industrial facilities, VR integrates immersive visualization, interactive exploration, and experiential learning into a comprehensive communication strategy that enhances public understanding of upstream oil and gas operations. The findings indicate that VR effectively simplifies complex technical concepts, increases information retention, stimulates public curiosity, and encourages more meaningful engagement with industrial activities. Consequently, VR represents an innovative communication medium capable of bridging the knowledge gap between industrial organizations and society while supporting more transparent, participatory, and sustainable communication practices.

This finding reinforces the argument that future public communication strategies in the upstream oil and gas sector should increasingly incorporate immersive technologies to improve communication effectiveness and strengthen relationships with surrounding communities.

Table 1 The Contribution of Virtual Reality to Enhancing Public Understanding of Upstream Oil and Gas Operations

Communication Dimension	Conventional Communication	Virtual Reality Communication	Communication Benefit
Information Delivery	Text, brochures, presentations, and videos	Immersive three dimensional simulation	More engaging and easier to understand
Audience Participation	Passive information recipients	Active exploration and interaction	Higher engagement and experiential learning
Understanding of Technical Processes	Limited visualization of complex operations	Direct observation of drilling, production, and offshore facilities	Improved comprehension of technical concepts
Safety Communication	Verbal explanation of procedures	Interactive simulation of emergency response and safety protocols	Better understanding of operational safety
Environmental Communication	General explanation of environmental impacts	Visualization of environmental monitoring and mitigation measures	Greater transparency and environmental awareness
Communication Outcome	Limited knowledge acquisition	Increased understanding, trust, and information retention	Stronger public support and stakeholder engagement

Source: Authors' synthesis based on the reviewed literature (2025)

Table 1 summarizes the comparative advantages of Virtual Reality over conventional communication media in facilitating public understanding of upstream oil and gas operations. The comparison demonstrates that VR introduces a shift from information transmission toward experiential communication, where audiences actively participate in constructing knowledge through immersive interaction. This transformation enhances not only cognitive understanding but also emotional engagement, transparency, and public confidence in industrial activities. The reviewed literature consistently indicates that these characteristics make VR a more effective strategic communication medium for explaining technically sophisticated operations while simultaneously strengthening stakeholder relationships and fostering informed public participation in the upstream oil and gas sector.

3.2. Virtual Reality Strengthens Stakeholder Engagement and Public Trust

Virtual Reality (VR) serves not only as an immersive communication technology but also as a strategic platform for strengthening stakeholder engagement and fostering public trust in upstream oil and gas operations. The literature consistently indicates that one of the greatest challenges faced by the upstream oil and gas industry is maintaining

constructive relationships with external stakeholders, particularly local communities affected by exploration and production activities. Industrial projects often generate public concerns regarding environmental degradation, occupational safety, marine ecosystem protection, and long term socioeconomic impacts. In many cases, these concerns emerge because communities possess limited access to accurate information and rely heavily on incomplete reports, media narratives, or personal assumptions. Consequently, communication strategies that merely provide technical explanations through brochures, public presentations, or corporate reports are often insufficient to address public uncertainty or establish mutual understanding. VR offers an alternative communication approach by allowing stakeholders to directly experience virtual representations of industrial operations, thereby creating a more transparent and credible communication environment.

The reviewed studies further reveal that VR significantly enhances stakeholder participation during public consultation and community engagement programs. Unlike conventional communication methods that primarily position community members as passive recipients of information, VR encourages active involvement by allowing stakeholders to interact with virtual operational environments. During immersive communication sessions, participants can virtually explore offshore platforms, observe drilling operations, inspect safety systems, and examine environmental management practices from multiple perspectives. This interactive experience enables individuals to formulate questions based on their own observations rather than relying solely on explanations provided by company representatives. Such active participation promotes more meaningful dialogue because discussions are grounded in shared visual experiences rather than abstract technical descriptions. As a result, communication becomes more collaborative, enabling companies and communities to exchange knowledge, clarify misunderstandings, and jointly explore potential solutions to emerging concerns.

Another important finding concerns the role of VR in improving organizational transparency and reducing information asymmetry. Information asymmetry frequently occurs when companies possess substantially more technical knowledge than surrounding communities, creating unequal access to information and potentially generating suspicion or distrust. The literature suggests that immersive communication technologies reduce this imbalance by providing stakeholders with realistic access to operational processes that would otherwise remain inaccessible due to geographical distance or safety restrictions. Through VR simulations, community members are able to observe environmental monitoring activities, pollution prevention systems, emergency response procedures, and operational safety standards that are difficult to communicate through conventional media. Such transparency enables stakeholders to independently evaluate industrial practices and better understand the measures implemented to minimize environmental and operational risks. Consequently, VR contributes to building organizational credibility because communication is supported by observable evidence rather than solely by corporate claims.

The literature also demonstrates that trust building is closely associated with communication quality rather than information quantity alone. Public trust develops when stakeholders perceive communication as open, transparent, consistent, and responsive to their concerns. VR supports these communication characteristics by creating immersive experiences that reduce ambiguity and facilitate shared understanding between industrial organizations and surrounding communities. Furthermore, immersive visualization allows companies to communicate complex issues,

including environmental mitigation strategies, biodiversity conservation, emergency preparedness, and operational risk management, in ways that are easier for nontechnical audiences to comprehend. Several reviewed studies indicate that stakeholders who participate in VR based communication programs exhibit greater confidence in the accuracy of the information provided and demonstrate higher willingness to engage in constructive dialogue. This suggests that immersive communication contributes not only to knowledge acquisition but also to the development of stronger emotional and psychological connections between organizations and stakeholders.

Overall, the synthesis of previous studies confirms that VR represents a transformative communication medium capable of strengthening stakeholder engagement while simultaneously fostering long term public trust. Rather than functioning solely as a technological innovation for visualization, VR facilitates two way communication characterized by participation, transparency, interaction, and mutual learning. These characteristics align closely with contemporary strategic communication approaches that emphasize stakeholder involvement as a prerequisite for achieving sustainable industrial development. For the upstream oil and gas industry, adopting VR as part of stakeholder communication strategies may improve social acceptance of industrial projects, reduce conflicts arising from misinformation, and strengthen collaborative relationships between companies, governments, and local communities. Therefore, VR should be considered a strategic communication investment that supports not only effective information dissemination but also the long term development of trust based relationships between industry and society.

Table 2 The Role of Virtual Reality in Strengthening Stakeholder Engagement and Public Trust

Stakeholder Communication Aspect	Conventional Communication	Virtual Reality Communication	Strategic Communication Outcome
Stakeholder Participation	Passive attendance during meetings and presentations	Active exploration of virtual industrial environments	Higher participation and engagement
Communication Transparency	Information delivered through reports and presentations	Direct visualization of operational activities and mitigation measures	Greater transparency and credibility
Public Understanding	Limited interpretation of technical explanations	Experiential understanding through immersive simulation	Improved comprehension of industrial processes
Dialogue and Consultation	One way communication dominated by company representatives	Interactive discussion based on shared virtual experiences	More collaborative and meaningful dialogue
Trust Building	Dependent on verbal explanations and corporate reputation	Evidence based communication supported by immersive	Increased public trust and organizational legitimacy

		visualization	
Social Acceptance	Potential resistance due to uncertainty and misinformation	Better understanding leading to informed public support	Stronger stakeholder relationships and social acceptance

Source: Authors' synthesis based on the reviewed literature (2025)

Table 2 demonstrates that the adoption of Virtual Reality transforms stakeholder communication from a conventional information dissemination model into an immersive and participatory communication process. Compared with traditional approaches, VR provides greater opportunities for stakeholders to directly observe industrial operations, evaluate environmental protection measures, and participate in evidence based discussions with industry representatives. This shift reduces information asymmetry while strengthening transparency, credibility, and mutual understanding between organizations and surrounding communities. Consequently, stakeholder engagement evolves from passive consultation toward active collaboration, supporting the development of public trust, organizational legitimacy, and long term social acceptance of upstream oil and gas operations.

3.3. The Adoption of Virtual Reality Requires Strategic Investment and Institutional Readiness

The third major finding indicates that although Virtual Reality (VR) offers substantial advantages as a strategic communication medium, its successful adoption requires significant strategic investment and strong institutional readiness. The literature consistently identifies implementation cost as one of the primary barriers to the widespread use of VR, particularly in industries characterized by complex operational environments such as upstream oil and gas. Developing an immersive VR application involves multiple stages, including three dimensional (3D) modeling, software development, scenario design, system integration, user interface optimization, and continuous content updates. In addition to software development, organizations must invest in specialized hardware, including high performance computers, VR head mounted displays (HMDs), motion tracking systems, and supporting network infrastructure. Ververidis et al. (2022) emphasizes that the production of high quality VR content requires considerable financial resources because realistic simulations depend on advanced graphics, interactive programming, and high computational performance. Similarly, Lee & Wu (2024), Seong & Park (2024) argue that immersive VR environments require sophisticated visualization technologies capable of delivering high frame rates, low latency, and accurate motion tracking to ensure user comfort and maintain a realistic experience. These technical requirements explain why VR implementation often represents a substantial initial investment for industrial organizations.

Beyond financial considerations, the reviewed literature suggests that technological readiness is another determining factor influencing the effectiveness of VR implementation. High quality immersive communication depends not only on the availability of hardware but also on the reliability of supporting technological infrastructure. According to Ferdani et al. (2020), Johansson & Roupé (2024), immersive VR applications require advanced graphics processing units (GPUs), sufficient computing power, responsive motion tracking devices, and stable software integration to deliver seamless virtual experiences. Hardware limitations may reduce image quality, increase

latency, and generate simulation instability, ultimately diminishing users' sense of presence and immersion. Furthermore, Ferguson et al. (2025) explain that current VR technologies continue to face limitations in reproducing multisensory experiences, particularly tactile, olfactory, and proprioceptive feedback. Although visual and auditory simulations have reached a high level of realism, accurately replicating physical sensations and environmental interactions remains technically challenging. Consequently, organizations intending to utilize VR for strategic communication must carefully evaluate their technological capacity before integrating immersive communication into stakeholder engagement programs.

The findings also demonstrate that institutional readiness extends beyond technological infrastructure and encompasses organizational capability to design communication experiences that are both technically accurate and audience oriented. Effective VR communication requires content that faithfully represents operational realities while simultaneously presenting complex industrial information in language and visual formats that can be understood by diverse stakeholder groups. In upstream oil and gas operations, communication content must accurately depict drilling activities, offshore production systems, environmental monitoring, emergency response procedures, and occupational safety practices without overwhelming audiences with excessive technical complexity. Wu et al. (2019) argue that successful VR applications depend largely on instructional design and user centered interaction rather than technological sophistication alone. Likewise, Afzal & Shafiq (2021) found that VR training and communication programs achieve higher effectiveness when simulation content is designed according to users' cognitive characteristics, learning objectives, and expected communication outcomes. These findings suggest that institutional readiness involves not only acquiring advanced technology but also developing communication strategies that prioritize audience comprehension and engagement.

Another critical aspect identified in the reviewed literature is the necessity of interdisciplinary collaboration throughout the VR development process. Unlike conventional communication media, immersive VR applications integrate knowledge from multiple professional disciplines, including engineering, communication, computer science, graphic design, psychology, and human computer interaction. Engineers provide technical accuracy regarding industrial operations, communication specialists translate complex information into understandable narratives, digital designers develop immersive visual environments, while software developers ensure system functionality and user interaction. According to Li et al. (2025), successful implementation of immersive technologies within industrial environments requires close collaboration among technical experts, instructional designers, and organizational decision makers to ensure that virtual environments accurately reflect real operational conditions while remaining accessible to intended users. Furthermore, Damianova & Berrezueta-Guzman (2025) demonstrate that interdisciplinary collaboration significantly improves the effectiveness of VR applications in hazardous environment training because communication objectives, technical realism, and user experience are developed simultaneously rather than independently. Therefore, institutional readiness should also be understood as an organization's ability to coordinate expertise across multiple disciplines in support of integrated communication objectives.

Although the implementation of VR requires considerable investment and organizational preparation, the literature consistently concludes that its long term benefits outweigh the initial costs. One significant advantage is the reduction of recurring

operational expenses associated with traditional communication activities, particularly physical site visits, large scale public outreach events, and repetitive face to face training sessions. Adami et al. (2021) report that VR based training reduces travel expenses, minimizes operational disruptions, and allows learning activities to be conducted repeatedly without requiring access to hazardous industrial facilities. Similarly, Menin et al. (2018) observe that immersive simulation improves knowledge retention, decision making, and operational preparedness while reducing safety risks associated with conventional field based learning. Within the context of public communication, VR enables organizations to reach broader audiences regardless of geographical location while simultaneously providing standardized communication experiences that maintain message consistency. Consequently, although development costs are relatively high, organizations may achieve greater communication efficiency and long term cost effectiveness through repeated utilization of immersive communication platforms (Ban et al., 2023; Chang et al., 2024; Kougioumtzidis et al., 2025).

This study suggests that the successful adoption of Virtual Reality should not be interpreted merely as the acquisition of an emerging digital technology but rather as a long term strategic investment in organizational communication capability. The reviewed literature consistently indicates that organizations capable of integrating technological infrastructure, institutional readiness, interdisciplinary collaboration, and audience centered communication strategies are more likely to maximize the benefits of immersive communication. For the upstream oil and gas industry, VR offers opportunities not only to improve public understanding of industrial operations but also to strengthen transparency, stakeholder relationships, and organizational legitimacy. Therefore, future communication strategies should position VR within broader organizational transformation initiatives that integrate digital innovation with strategic communication, stakeholder engagement, and sustainable corporate governance. Such an integrated approach will enable VR to function as a powerful communication platform that supports both industrial competitiveness and long term public trust.

4. Conclusion

This study demonstrates that Virtual Reality (VR) possesses considerable potential to function as a strategic communication medium for enhancing public understanding of upstream oil and gas operations. Based on the qualitative synthesis of the reviewed literature, three major findings were identified. First, VR improves public understanding by transforming complex technical information into immersive and interactive communication experiences that facilitate experiential learning and increase information retention. Second, VR strengthens stakeholder engagement and public trust by promoting transparency, reducing information asymmetry, and encouraging more active participation in industrial communication processes. Third, the successful implementation of VR depends on strategic investment, technological infrastructure, institutional readiness, and interdisciplinary collaboration, indicating that organizational capability is equally important as technological innovation in maximizing the effectiveness of immersive communication.

The discussion further suggests that the contribution of VR extends beyond visualization technology toward a broader strategic communication function. Unlike conventional communication media that primarily deliver information in a one way manner, VR enables stakeholders to actively experience industrial operations, observe environmental protection measures, and participate in more meaningful communication

processes. Consequently, VR supports contemporary communication principles emphasizing transparency, participation, dialogue, and trust building. The findings therefore contribute to communication scholarship by positioning immersive technology as an emerging communication platform capable of bridging the knowledge gap between industrial organizations and society while supporting more sustainable stakeholder relationships in complex industrial environments such as the upstream oil and gas sector.

Despite these contributions, this study has several limitations. The findings are based exclusively on qualitative analysis of existing literature and therefore do not provide empirical evidence regarding public perceptions or behavioral responses toward VR based communication. In addition, the review focuses primarily on studies published in English, which may limit the inclusion of relevant findings from other linguistic or regional contexts. Future research should employ empirical approaches, including experiments, surveys, case studies, or mixed methods, to evaluate the effectiveness of VR communication programs in improving public understanding, trust, and stakeholder engagement. Comparative studies examining Virtual Reality alongside other immersive technologies, such as Augmented Reality, Mixed Reality, and Digital Twins, would also provide valuable insights into the future development of strategic communication within the upstream oil and gas industry and other high risk industrial sectors.

Conflict of Interest

The authors declare no conflict of interests.

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