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# Quad Media Integration in Agricultural Extension Services: Its Impact on Rice Production Outcomes in Region 02, Philippines

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**ABSTRACT**

This research assessed the use, efficacy, and recognition of different communication and extension approaches utilized by the Department of Agriculture – Regional Field Office 02 among rice farmers in Region 02, Philippines. With the descriptive quantitative design, data were collected from 846 farmer-respondents in 60 municipalities using a structured survey questionnaire. Descriptive statistics and Spearman's rank correlation were used to analyze the data gathered. Findings showed that interpersonal and print strategies, such as flipcharts, brochures, and techno-demo field days, were the most highly rated and utilized for effectiveness and preference. In comparison, digital platforms, broadcast, and mobile-based strategies were rated with limited reach and scope. Moreover, the use of communication strategies was not statistically significantly related to rice production in wet as well as dry seasons. These findings suggest that even though traditional channels of communication are still effective, digital literacy, infrastructure, and content clarity must be enhanced to promote adoption of newer platforms. The study recommends combining farmer-priority channels with improved digital support to enable inclusive, efficient, and effective agricultural extension delivery.

**Keywords:** *Agricultural communication strategies, rice farmers, information dissemination, Spearman correlation, communication effectiveness*

## Introduction

Agricultural growth in ASEAN is rooted in its high agro-ecological diversity, which sustains the production of staple foods like rice, maize, and root crops (FAO, 2020). Staple crops are not only essential for food security but also as core sources of income for millions of rural households (ADB, 2019). Rice, locally known as palay when still unhulled, is the main staple crop and covers some 40% of overall agricultural land space, with the majority of it being farmed by smallholder farmers (PSA, 2022).

The Philippine Statistics Authority (PSA) considers palay as mature rice grains that have not yet been milled. Region-wise production, Region 02 (Cagayan Valley) is one of the country's rice granaries. In 2020, the area yielded 2.45 million metric tons (MMT) of palay, or 12.7% of domestic production (PSA, 2020). The provinces of Isabela and Cagayan contributed more than 85% of this figure, which confirms the region's strategic place in the rice economy of the nation.

To contribute to the rice industry, the Department of Agriculture Regional Field Office 02 (DA RFO 02) adopts a battery of communication and extension approaches to speed up the diffusion of technology and innovations. These include quad-media practices—print, broadcast, audio-visual, and digital—and are complemented by interpersonal contacts like technology demonstrations and field days. These approaches are undertaken through major DA units such as the Rice Program, the Research and Development Division, and the Regional Agriculture and Fisheries Information Section (RAFIS).

Appreciating that communication is a key technology adoption driver, DA RFO 02 started the Rice Model Farm Cluster Project in 2017 to be able to demonstrate hybrid rice seeds comparative advantage over the conventional varieties. The project is based on participatory extension and focuses on the extension of timely, locally applicable agricultural information.

Communication strategies, theorized in development communication literature (Rogers, 2003; Servaes, 2008), are the formal methods by which information is exchanged to bring about behavior change. These can be verbal (oral and written), non-verbal, or visual. In extension agriculture, these strategies come into play to shape farmers' attitudes and practices (Leeuwis & van den Ban, 2013).

Nonetheless, newer literature points to recurring shortages in assessing the performance of these communication channels, especially under rural settings where access, pertinence, and farmer preferences significantly differ (Agunga & Manda, 2014; Dejene et al., 2021). Although earlier research has looked at extension service delivery, few have systematically evaluated the performance of quad-media communication concerning content clarity, recall, engagement, and acceptability of rice farmers in Region 02.

This research fills that gap by evaluating the impact of communication and extension strategies in transferring, promoting, and adopting rice-related technologies in Region 02. More specifically, it aimed to identify farmers' preferences and attitudes towards various communication channels and their characteristics. The fundamental concern is not just whether there are communication strategies, but the extent to which

these strategies impact farmers' technology adoption behaviors in a region where agriculture is a vital source of livelihood.

By placing emphasis on recent statistics and incorporating newer research conducted over the last five years, this article adds to the expanding evidence based on farm communication and provides practical recommendations for extension practice improvements in comparable regional settings. The results are intended to guide strategic planning for DA RFO 02 and other actors in narrowing technology adoption gaps, enhancing message transmission, and sustainably augmenting rice productivity.

Furthermore, this study contributes to the documentation and assessment of communication and extension strategies utilized in Region 02 for the dissemination and promotion of rice agriculture technologies. By identifying farmers' levels of awareness, usage patterns, and preferred channels, the study offers practical guidance on which communication strategies are most effective and widely accepted by rice farmers.

The results can be used as a guide for crafting responsive and relevant communication materials, enhancing the delivery of messages, and aligning communication efforts between implementing agencies. Moreover, this research informs policy orientations in congruence with transparency and accountability under the Freedom of Information (FOI) policy framework.

Despite the range of communication and extension strategies being implemented in Region 02, there is limited empirical evidence on how effectively these strategies reach, influence, and are perceived by rice farmers. It remains unclear which strategies are most widely used, preferred, and impactful in terms of knowledge transfer and income improvement. This study sought to address this gap by evaluating the effectiveness of the current approaches and understanding their relationship to farmer outcomes. The general objective of this study was to assess the effectiveness of communication and extension strategies among rice farmers in the model cluster areas of Region 02. Specifically, it aimed to determine the socio-demographic profile of the respondents; assess the level of awareness of respondents regarding different communication and extension strategies (print, broadcast, video/television, social media, interpersonal, mobile, techno-demo, field days, summits, forums, trainings, and caravans); identify the extent of use of these communication and extension strategies by the respondents; determine the preferred strategies for adopting rice-related technologies; and analyze the relationship between the respondents' yield and their use and application of knowledge gained from communication and extension strategies.

## Methods

This research utilized a descriptive-quantitative study design in evaluating the impact and farmer acceptance of communication and extension plans implemented by DA RFO 02 in Region 02.

### Study Area and Respondents

The research was implemented in the rice-producing pilot municipalities of Cagayan, Isabela, Nueva Vizcaya, and Quirino—major rice areas in Region 02 under the Department of Agriculture's Rice Model Farm Cluster Project. These municipalities are irrigated places with intensive rice farming.

A total of 846 rice model farmers were chosen through simple random sampling from a sampling frame of 60 municipalities covered by the project. Each municipality had the number of respondents proportionally assigned according to the population of

registered model farmers in each municipality. The sampling frame and master lists were provided by the Field Operations Division, the Knowledge Management and Learning Center (KMLC) of DA RFO 02, and the respective Provincial and Municipal Agriculture Offices.

**Data Gathering**

Primary data were collected via a self-administered questionnaire survey using Likert-scale items on the levels of awareness, levels of use, communication strategies of choice, and perceived effectiveness of these strategies among farmers. To complement the quantitative information, semi-structured interviews were conducted with chosen farmer-beneficiaries and DA staff.

**Instrument Reliability**

The instrument was pre-tested for content validity by communication and agricultural extension experts to ensure its content validity. A pilot test was done using a sample of small rice farmers outside the study site to enhance the items' clarity and internal coherence. Cronbach's alpha was used to examine the items' reliability in the scale, which provided an acceptable threshold (>.70).

**Data Analysis**

Descriptive statistics were used to summarize the data. These were the percentages, frequencies, and weighted means to summarize respondents' socio-demographic characteristics, level of awareness, usage level, and communication strategy.

For testing associations among variables, e.g., among the usage of strategies and farmers' income reports, Spearman's Rank Correlation Coefficient was employed. This non-parametric process was applicable for ordered data from Likert scale-based questions and made no demand for normal distribution.

**Ethical Considerations**

The study adhered to ethical guidelines. Informed consent was obtained, ensuring voluntary participation and privacy protection. Confidentiality and anonymity were maintained, and data were handled responsibly. Farmers were treated fairly, and potential harm was minimized.

## Results and Discussion

This section reports the study results based on the survey data from 846 rice model farmers in the sample municipalities in Region 02.

Table 1 shows the demographic profile of the 846 farmer-respondents. They were predominantly in the older age groups, with 30.73% in the 51–60 age group, followed by 28.01% in the 41–50 age group, and 23.40% aged 61 years and older. The respondents in the 31–40 and 20–30 years of age groups were very low at 13.00% and 4.85%, respectively. These numbers imply that the agricultural population of the study area is largely made up of middle-aged to older persons, which would mean that there may be a generation gap, and this further raises questions regarding the succession of farm knowledge and labor.

The respondents were largely males, making up 82.03% of the sample, whereas females accounted for a mere 17.97%. Such a distribution is consistent with

conventional gender roles in rural farming communities, where men are better positioned to be occupied full-time with farming and farm decision-making. Religiously, the vast majority (95.51%) of the participants were Roman Catholic, in keeping with the dominant religious affiliation of the area. Slightly smaller percentages indicated membership in Iglesia ni Cristo (0.71%) and other religious affiliations (3.78%).

**Table 1. Demographic Characteristics of Farmer-Respondents; *n=846***

| Demographics | Frequency | Percentage |
|---|---|---|
| Age | | |
| 20–30 | 41 | 4.85 |
| 31–40 | 110 | 13.00 |
| 41–50 | 237 | 28.01 |
| 51–60 | 260 | 30.73 |
| 61 Above | 198 | 23.40 |
| Gender | | |
| Male | 694 | 82.03 |
| Female | 152 | 17.97 |
| Religion | | |
| Roman Catholic | 808 | 95.51 |
| Iglesia ni Cristo | 6 | 0.71 |
| Others | 32 | 3.78 |
| Language Spoken | | |
| Ilocano | 644 | 76.12 |
| Itawes | 113 | 13.36 |
| Others | 43 | 5.08 |
| Ibanag | 40 | 4.73 |
| Tagalog | 6 | 0.71 |
| Other Dialect Spoken | | |
| Tagalog | 737 | 87.12 |
| Ilocano | 89 | 10.52 |
| Ibanag | 14 | 1.65 |
| Itawes | 6 | 0.71 |
| Educational Attainment | | |
| No Schooling | 2 | 0.24 |
| Elementary Undergraduate | 25 | 2.96 |
| Elementary Graduate | 239 | 28.25 |
| High School Undergraduate | 152 | 17.97 |
| High School Graduate | 238 | 28.13 |
| Vocational/Technical | 24 | 2.84 |
| College Undergraduate | 80 | 9.46 |
| College Graduate | 86 | 10.17 |
| Livelihood | | |
| Farming | 846 | 100.00 |
| Land Ownership | | |
| Owned | 553 | 65.37 |
| Leased | 286 | 33.81 |
| Prefer Not to Say | 7 | 0.83 |

Language use among the respondents indicated that Ilocano was the most frequently used native language (76.12%), which was followed by Itawes (13.36%), Ibanag (4.73%), and Tagalog (0.71%). When respondents were asked about other

languages they spoke, 87.12% reported that they could speak Tagalog, an indication of widespread bilingualism or multilingualism that could improve communication outside the local area and promote access to agricultural programs and extension services.

In terms of educational level, the largest group of respondents was elementary graduates (28.25%) and high school graduates (28.13%). A significant proportion had not finished high school (17.97%), whereas merely 10.17% had attended college. The low percentage of respondents who were educated to higher levels indicates that farmers might have restricted access to formal agricultural education and perhaps depend greatly on indigenous knowledge or knowledge based on the community.

All the respondents indicated farming as their main area of livelihood (100%), thereby affirming that the sample is made up of only individuals directly involved in agriculture. With regard to land ownership, 65.37% of them owned the land they cultivated, and 33.81% were cultivating leased land. A negligible percentage (0.83%) did not indicate their status of land ownership. The high level of land ownership suggests a relatively secure agricultural base, although a considerable number of leaseholders were subject to restrictions in securing credit and long-term investment in their farms.

To meet the goal of gauging the level of awareness of respondents on the different communication and extension strategies employed by DA RFO 02, respondents were requested to rank strategies from Rank 1 (most preferred) to Rank 5 (least preferred). It was the assumption that, if a respondent ranked a strategy, it meant awareness of the strategy—an approach known as inferred awareness.

Table 2 presents the number of ranks assigned to each communication strategy. The results indicate that interpersonal communication was ranked as the most known strategy, with 710 out of 846 respondents (83.92%) ranking it. It indicates high exposure and awareness of face-to-face communication, like farmer meetings, consultations, and visits by extension workers. The print strategy was the second best known, with 561 people (66.31%) placing it on the list. This demonstrates continued familiarity with printed media like leaflets, brochures, and newsletters, which are still useful in rural extension work.

**Table 2. Inferred Awareness of DA-RFO 02 Communication and Extension Strategies Based on Respondents' Rankings**

| Communication Strategies | No. of Respondents Who Ranked It | Inferred Awareness (%) |
|---|---|---|
| Interpersonal | 710 | 83.92 |
| Print | 561 | 66.31 |
| Videos/Television | 78 | 9.22 |
| Broadcast | 76 | 8.98 |
| Mobile Phones | 42 | 4.96 |
| Social Media and Networking Sites | 39 | 4.61 |
| Prefer Not to Say | 2724 | N/A |

Conversely, mass and contemporary media tactics revealed much lower awareness. Broadcast was ranked by only 8.98% of the respondents, and videos/television by 9.22%, while mobile phones (4.96%) and social media and networking sites (4.61%) ranked lowest in inferred awareness. This reveals that despite

growing popularity for digital communication, these tactics are either less utilized or not readily available to Region 02 rice farmers. In addition, there were many non-responses (shown as "Prefer not to say") recorded, with 2,724 responses across all ranks, further underscoring limited familiarity or use of strategies other than interpersonal and print communication.

Knowing the performance and coverage of different communication and extension mechanisms is essential in ensuring that agrotechnology and innovations are effectively passed on to rice farmers. In the case of Region 02, affected by socio-economic and infrastructural circumstances regarding information availability, quantifying farmers' perception and adoption of different media serves as an input for future program design. The following results reflect the respondents' perceived effectiveness and visibility of individual strategies—specifically, the communication channels most preferred by the respondents and the areas where broadcast and digital media may require further development or provision.

The communication tactics information reveals that interpersonal and print media approaches remain the most effective way of disseminating agricultural information for the farmer-respondents, as shown in Table 3.

**Table 3. Extent of Use of Various Communication and Extension Strategies Among Farmer-Respondents**

| Communication Strategies | Weighted Score | Verbal Description |
|---|---|---|
| Prints | | |
| Techno Guide | 4.249 | Great Extent |
| Brochures | 4.517 | Great Extent |
| Leaflet | 4.657 | Great Extent |
| Flipcharts | 4.692 | Great Extent |
| Posters | 2.876 | Little Extent |
| Newsletter | 2.532 | Very Little Extent |
| Broadcast | | |
| DWDA 105.3 FM Radio Program | 2.455 | Very Little Extent |
| School-on-the Air | 2.436 | Very Little Extent |
| Radio Plugs/Jingles | 2.065 | Very Little Extent |
| Video/Television | | |
| TV Plugs/Jingles | 1.476 | No Extent |
| Audio Visual | 1.476 | No Extent |
| Presentation/Videos | 1.476 | No Extent |
| Social Media and Networking Sites | | |
| DA Website | 1.968 | Very Little Extent |
| DA Rehiyon Dos | 1.968 | Very Little Extent |
| Interpersonal | | |
| Techno-Demo Field Day | 4.856 | Great Extent |
| Farm Festival Summit | 3.085 | Little Extent |
| Information Caravan | 3.193 | Little Extent |
| Mobile Phones | | |
| Short Messaging System | 1.440 | No Extent |
| Text Hotlines | 1.427 | No Extent |

Under the category of prints, flipcharts (4.692), leaflets (4.657), brochures (4.517), and techno guides (4.249) were rated to a great extent, and this reflects farmers' liking for tangible, easy-to-understand material. Conversely, posters (2.876) and newsletters (2.532) were moderately effective to a very little extent.

On the contrary, broadcast media ranked with lower weighted scores. Radio programs based on radio, including DWDA 105.3 FM (2.455), School-on-the-Air (2.436), and Radio Jingles (2.065), were deemed effective to a very little extent, either implying limited access or waning popularity of radio as an information outlet.

Additionally, video and television media, such as TV plugs, audio-visual shows, and other video content, were found to be the least effective, with each having only 1.476, translated to no extent. This might indicate difficulties in TV access, electricity, or digital literacy issues within the target population.

Similarly, social media platforms, such as the DA website and DA Rehiyon Dos Facebook account, were scored low (1.968, or Very Little Extent), as perhaps internet availability is poor or digital participation by farmers is poor in the region.

Furthermore, interpersonal communication was the most effective method. techno-demo field days had the most heavily weighted score (4.856, Great Extent) to indicate strong admiration for interactive, hands-on learning strategies. Farm festivals (3.085) and information caravans (3.193) were measured to a limited extent, indicating that although still useful, they may be restricted by timing, location, or logistical factors.

The following table evaluates how farmer-respondents in Region 02 perceived the quality of various communication strategies based on key attributes. This complements earlier findings on usage by highlighting why certain strategies, like print and interpersonal, are preferred. The communication tactics information reveals that print media and interpersonal communication remain the most effective methods of disseminating rice-related technologies among farmer-respondents in Region 02. Under the prints category, all six evaluated attributes — acceptability (4.617), content (4.570), layout attractiveness (4.619), persuasion (4.607), recall the point featured (4.648), and self-involvement (4.616) — received weighted scores indicating strong agreement. This demonstrates farmers' strong preference for tangible, well-designed materials that are content-rich and personally engaging.

In contrast, broadcast media ranked moderately in terms of preference. Attributes such as acceptability (4.166), content (4.172), persuasion (4.173), recall (4.166), and self-involvement (4.166) all received moderate agreement, except layout attractiveness (4.889), which was strongly agreed upon. This suggests that while broadcast formats are visually effective, they may not be as engaging or impactful in delivering content compared to print.

Video and television-based communication strategies had no available data, indicating either low exposure, poor recall, or non-usage of these channels. This may suggest issues with access to electricity, availability of television, or limited use of video-based materials in dissemination efforts.

Social media and networking platforms received mixed but generally favorable responses. Most attributes, including targeting, technology, visual appeal, user interaction, accessibility, user interest, and customization, scored consistently at 4.330 (Strongly Agree), showing that farmers find SNS engaging, relevant, and accessible. However, clarity (3.758) was slightly lower, suggesting a potential need to simplify language or improve the structure of content on these platforms.

**Table 4. Perceived Effectiveness of Communication Strategies for Rice Technology Dissemination**

| Strategies | Attribute | Score | Verbal Description |
|---|---|---|---|
| Prints | | | |
| | Acceptability | 4.617 | SA |
| | Content | 4.570 | SA |
| | Layout Attractiveness | 4.619 | SA |
| | Persuasion | 4.607 | SA |
| | Recall the Plot Featured | 4.648 | SA |
| | Self-Involvement | 4.616 | SA |
| Broadcast | | | |
| | Acceptability | 4.166 | MA |
| | Content | 4.172 | MA |
| | Layout Attractiveness | 4.889 | SA |
| | Persuasion | 4.173 | MA |
| | Recall the Plot Featured | 4.166 | MA |
| | Self-Involvement | 4.166 | MA |
| Video/TV | | | |
| | Acceptability | - | - |
| | Content | - | - |
| | Layout Attractiveness | - | - |
| | Persuasion | - | - |
| | Recall the Plot Featured | - | - |
| | Self-Involvement | - | - |
| Social Media and Networking Sites | | | |
| | Clarity | 3.758 | MA |
| | Target | 4.330 | SA |
| | Technology | 4.303 | SA |
| | Visual Appeal | 4.330 | SA |
| | User Interaction | 4.330 | SA |
| | Accessibility | 4.330 | SA |
| | User Interest | 4.330 | SA |
| | Customization | 4.330 | SA |
| Interpersonal | | | |
| | Clarity | 4.553 | SA |
| | Topics | 4.536 | SA |
| | Length of Event | 4.561 | SA |
| | Time Dissemination | 4.561 | SA |
| | Accessibility | 4.546 | SA |
| | Total of Interpersonal CS | 4.531 | SA |
| Mobile Phone | | | |
| | Clarity of Message | 4.250 | SA |
| | Time Spent | 4.000 | MA |
| | Length of Text | 4.000 | MA |
| | Signal/Strength | 4.000 | MA |
| | Accessibility | 4.000 | MA |
| | Total Interpersonal CS | 4.000 | MA |

In terms of interpersonal communication, all attributes — clarity (4.553), topics (4.536), length of event (4.561), time dissemination (4.561), and accessibility (4.546) — were rated as Strongly Agree, with an overall weighted score of 4.531. This reaffirms that farmers continue to value personal interaction, dialogue, and participatory methods as key learning avenues.

Meanwhile, mobile phone-based communication was moderately preferred. clarity of message (4.250) was strongly agreed upon, while attributes like time spent, length of text, signal strength, and accessibility hovered at exactly 4.000 (Moderately Agree). This suggests that while mobile-based communication is accessible, limitations like message length, network issues, or reduced engagement could be affecting its full potential.

Building on the earlier findings regarding farmers' preferences and perceptions of various communication and extension strategies, it is also important to explore whether the use of these strategies is associated with tangible outcomes, such as rice yield. By examining the relationship between strategy application and productivity during both wet and dry seasons, further insight is provided into the effectiveness of communication efforts beyond awareness and preference, offering a broader view of their practical influence on farm performance.

The Spearman correlation between the mean degree of application of extension and communication strategies and rice yield (wet season and dry season), as shown in Table 5, showed generally weak and insignificant correlations.

On dry season yield, the correlation coefficients varied between -0.1606 (mobile phones) and 0.0441 (social media), showing a very weak or trivial monotonic relationship. All p-values were larger than 0.05, supporting the fact that no statistically significant correlations exist between the use of communication strategy and dry season yield.

For wet season yield, the trend was also the same. The social media (0.1359) had the strongest correlation, while the weakest was for video/television (0.0115). Yet again, none of the correlations were significant at the 0.05 level.

In general, regardless of different levels of usage for various communication strategies, the correlation coefficients indicate that no particular communication strategy had a significant or statistically significant relationship with yield in either season. The direction of relationships was also inconsistent—some strategies had slightly positive, others slightly negative correlations, but all were too weak to infer any dependable trend.

**Table 5. Spearman Correlation between Yield and Extent of Use of Various Communication Strategies**

| Communication Strategies | Correlation Coefficient | | Sig. (Dry) | Sig. (Wet) |
|---|---|---|---|---|
| | *Dry* | *Wet* | | |
| Prints | (0.0844) | (0.1013) | 0.6698 | 0.0666 |
| Broadcast | (0.0582) | (0.0307) | 0.4625 | 0.8098 |
| Video/Television | (0.0806) | 0.0115 | 0.8048 | 0.9492 |
| SNS | 0.0441 | 0.1359 | 0.2710 | 0.3970 |
| Interpersonal | 0.0231 | 0.0130 | 0.7190 | 0.8127 |
| Mobile Phones | (0.1606) | 0.0250 | 0.9138 | 0.9034 |

*(*) means there is a statistically significant monotonic relationship between the extent of use of a communication or extension strategy and rice yield*

## Conclusion and Future Works

This research indicated that interpersonal and printed communication strategies were the most efficient way to discuss with farmers in Region 02 about rice-based farming systems. The farmers favored traditional tools such as flipcharts, brochures, and field demonstrations, representing them as a format of learning that is interactive, visually stimulating, and hands-on. This is in line with the findings of Adhikari et al. (2020), who had revealed the continuous power of printed materials in rural Nepal, and the observation of Salami et al. (2021), which stressed that personal communication remains the central piece of agricultural extension in Nigeria.

Relative to this, electronic channels such as social media, video/TV, and mobile communication were perceived as being less suitable. Farmers' happiness concerning clarity, engagement, and access was only from moderate to low. This is in line with the viewpoint of Silva et al. (2022), who argued that the lack of infrastructure and low digital skills are the major challenges for carrying out effective technology transfer through digital means. Similarly, Mkhatshwa and Curtis (2022) also argued that rural farmers in South Africa tend to rely more on direct interactions and printed materials rather than digital or broadcast media due to issues with connectivity and trust.

Based on the findings, the impact of communication strategies on rice yields during both the wet and dry seasons was found to be not significant. Though farmers might be using or conscious of certain strategies, these instances may not necessarily result in increased productivity. A similar conclusion is made by Ayinde et al. (2021), who found that communication activities on their own, without continuous extension support and the local context, are unlikely to bring noticeable yield improvements.

In conclusion, it is recommended for DA RFO 02 to maintain print and interpersonal communication methods as they are the farmers' most preferred ones and considered to be the most effective in terms of usage and preference.

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## Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper. No financial, institutional, or personal relationships have influenced the design, implementation, analysis, or reporting of this study. Furthermore, the authors affirm that the research was conducted free from any editorial or review conflicts, and there was no external funding or sponsorship that could have affected the outcome or interpretation of the findings.

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**Artificial Intelligence (AI) Declaration Statement**

Artificial intelligence (AI) tools were employed in the preparation of this manuscript to support writing, language enhancement, and reference formatting. Specifically, OpenAI's ChatGPT was used to assist in organizing content structure, summarizing thematic discussions, and refining academic tone. The authors ensured that all AI-generated content was critically reviewed, edited, and fact-checked for accuracy, integrity, and relevance to the research objectives. All analytical interpretations, data inputs, and conclusions presented in the manuscript remain the sole intellectual work of the authors.