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Policy

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Editor's Note

Dear Scholars and Distinguished Colleagues,

We are delighted to announce the publication of Volume VI, Issue II of the *JCAS*. Over the past several years, the quality and impact of research published in *JCAS* have continued to grow, with articles increasingly being cited in the Thai Citation Index (TCI) and internationally indexed journals within Scopus. These achievements reflect our unwavering commitment to academic excellence and the collective efforts of our authors, reviewers, editorial board members, and readers.

The contemporary global landscape is undergoing profound geopolitical and geoeconomic transformations. As China and ASEAN economies continue to play increasingly influential roles in shaping regional and global development, scholars are presented with new opportunities and challenges for research and policy analysis. At the same time, emerging issues such as the SDGs, sustainability, digital transformation, media marketing, innovative pedagogical approaches, and artificial intelligence (AI) have become critical areas of scholarly inquiry, demanding rigorous examination and interdisciplinary perspectives.

The articles featured in this issue have undergone a rigorous triple-blind peer-review process, ensuring the highest standards of academic quality, originality, and relevance. We believe that the studies presented herein will contribute meaningful insights and advance scholarly understanding across a range of disciplines. Our continued adherence to a stringent review process underscores our dedication to establishing *JCAS* as a leading scholarly journal in the field of China-ASEAN studies. In both the short and long term, we aspire to achieve broader recognition through inclusion and advancement within major international indexing systems, including TCI Tier 1, TCI Tier 2, and Scopus.

JCAS distinguishes itself through its broad interdisciplinary scope, encompassing research in areas such as human resource and workforce development, China-Thailand relations, business and management, health and well-being, tourism and hospitality, leisure studies, information technology, finance and accounting, communication arts, economics, education, humanities, art and design, linguistics, applied sciences, sports sciences, and engineering. By fostering dialogue across disciplines, the journal seeks to promote innovative thinking and address complex issues facing contemporary societies.

The primary mission of *JCAS* is to provide a prestigious academic platform for scholars, practitioners, and students to disseminate high-quality theoretical and empirical research. We welcome submissions in both English and Chinese, encouraging multilingual scholarship and cross-cultural academic exchange. Through the publication of intellectually rigorous and socially relevant research, *JCAS* aims to facilitate scholarly dialogue, promote methodological advancement, and contribute to the development of best practices across diverse fields of study.

On behalf of the Editorial Board, we extend our sincere gratitude to our contributors, reviewers, and readers for their continued support. We warmly invite scholars and researchers from around the world to submit their work and join us in advancing academic knowledge and fostering international collaboration in China-ASEAN studies.

Your sincerely



Editor-in-Chief

Assist. Prof. Dr. Chun-Shuo Chen

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Interpreting for Tourism: Enhancing Communicative Competence through Peer and Self Evaluation

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Abstract

This study examines how short consecutive interpretation tasks in a tourism context enhance EFL (English as foreign language) university students' spoken communicative competence from a cognitive language learning perspective. Grounded in the noticing and output hypotheses, it investigates whether real-time interpreting promotes learners' awareness of linguistic and discourse-level deficiencies through active verbalization, peer assessment, and self-reflection. English-major students interpreted authentic travel guide content from Chinese into English and received structured peer feedback. Performances were evaluated using CEFR-based descriptors, and peer and instructor ratings were compared using t-tests. Qualitative analyses of peer comments and reflective writing from the interpreting students further explored perceived communicative weaknesses.

Results showed close alignment between peer and instructor ratings in range, accuracy, fluency, and interaction. However, peers consistently rated discourse coherence more favorably than instructors, suggesting limited sensitivity to global discourse organization under high cognitive load. Reflective writing enabled students to identify lexical, grammatical, and strategic gaps and consider alternative communicative approaches. The findings indicate that short consecutive interpretation functions as an effective output-driven task that fosters noticing and communicative development. The study recommends embedding profession-specific interpreting tasks, structured peer assessment, and guided reflective practice into English for Specific Purposes (ESP)-oriented EFL curricula, with explicit instruction in discourse coherence.

Keywords: Communicative Competence; Consecutive Interpretation; English for Specific Purposes

1. Introduction

Developing communicative competence is a key goal in English as a Foreign Language (EFL) education. However, a gap persists between classroom practice and authentic communication. To bridge this divide, task-based learning and reflective practices are increasingly used to simulate real-world interaction (Willis & Willis, 2020). Among these, interpretation tasks are particularly effective, as they integrate multiple skills and demand high levels of language competence (Dong, 2018). Though considered one of the most challenging tasks for bilinguals (Al-Harashsheh et al., 2020; Christoffels & de Groot, 2005), this complexity

makes interpretation a powerful tool for language learning. In universities, interpretation courses focus not on professional training but on improving overall English proficiency. These tasks help students identify and address language gaps in contexts that reflect real-life communication, promoting deeper engagement and learning.

Interpretation tasks uniquely expose students' linguistic gaps while strengthening overall English proficiency. As learners navigate the cognitive and linguistic demands in real time, their language weaknesses become apparent, prompting reflection and growth. This process heightens language awareness and fosters metacognitive skills such as self-monitoring and self-assessment, key to second-language development (Nakatani, 2005). Thus, interpretation serves as both a communicative task and a metacognitive tool, promoting learner autonomy and meaningful language progress.

Building on this perspective, recent research underscores the benefits of self-assessment and reflection in spoken language tasks. Rotjanawongchai (2024) found that self-recorded conversations enhance learners' communicative confidence and willingness to speak, key factors in handling tasks like interpretation. Likewise, Kitjaroochai (2023) identified the challenges EFL students face and the strategies they use during communication. These studies suggest that reflective practices not only support interpretation performance but also strengthen overall communicative and metacognitive skills.

Expanding on the focus on reflection and self-assessment, this study examines Chinese-to-English consecutive interpretation tasks, which require real-time comprehension and production. These tasks prompt learners to engage deeply with their language use and notice gaps in their communicative competence. Focusing on EFL university students, the study explores how interpretation fosters language proficiency and metacognitive awareness. Using both quantitative assessments and qualitative reflections, it investigates the pedagogical value and challenges of integrating interpretation into EFL instruction.

2. Literature Review

Language learning occurs when learners notice gaps in their understanding and adjust their output accordingly. This study investigated how short consecutive interpretation tasks help EFL learners identify and address gaps in their English proficiency, leading to improved language production (Leeser, 2008; Zalbidea, 2021). From a pedagogical perspective, recognizing and responding to such gaps is essential for developing communicative competence, highlighting the value of interpretation as a tool for language output and learning.

Short-consecutive interpretation requires the speaker and interpreter to alternate turns, demanding active listening, message analysis, and accurate delivery in the target language. This study uses a Chinese-to-English task to examine students' oral output through the lens of Swain's output hypothesis, which argues that language production promotes learning by making learners aware of gaps in their ability to express meaning (Li & Sun, 2023; Swain, 2005; Zalbidea, 2021). The following literature highlights the role of such tasks in helping learners confront and address these weaknesses.

2.1 Noticing and Language Learning

Noticing plays a central role in second language acquisition. Schmidt (1993) defines noticing as the learner's conscious attention to linguistic form, arguing that exposure to input alone does not guarantee acquisition unless specific features are attended to. In this sense, negotiation for meaning does not automatically result in learning because of increased input quantity; rather, its pedagogical value lies in how it creates conditions that prompt noticing.

Importantly, the present study does not treat negotiation for meaning as a mechanism that directly generates comprehensible input. Instead, it adopts a process-oriented view in which interaction may trigger learner output, and it is this output, particularly when learners are required to verbalize actively, that facilitates noticing. Swain's (1985) Output Hypothesis clarifies this distinction by arguing that pushed output obliges learners to test hypotheses about language use and, crucially, to recognize gaps between what they intend to express and what they are able to produce. This gap recognition constitutes a key form of noticing.

Empirical studies further support the role of output-driven noticing. Izumi (2002) demonstrated that tasks requiring learners to produce language led to greater retention of grammatical forms than comprehension-based exposure alone. Similarly, Leeson (2008) found that output-oriented tasks generated higher levels of form awareness than tasks emphasizing input processing only. These findings indicate that noticing often emerges during production, not merely from enhanced input.

From this perspective, active verbalization such as reformulating utterances, engaging in self-repair, or responding to peer feedback should be understood as an output-based cognitive process rather than an input-related one. Nation and Newton (2009) further note that speaking tasks that encourage reflection and monitoring foster metalinguistic awareness, thereby strengthening noticing. Recent discussions of output likewise emphasize that noticing is frequently mediated by task demands that require learners to articulate, evaluate, and revise their language use (Zalbidea, 2021).

Accordingly, in the context of short consecutive interpreting tasks, peer interaction and feedback do not function primarily as sources of additional comprehensible input. Instead, they operate as output-pushing mechanisms that prompt learners to verbalize actively, reflect on form–meaning relationships, and notice deficiencies in their own production. This reconceptualization resolves the apparent logical gap by situating verbalization squarely within the output domain, while recognizing its indirect but crucial role in facilitating noticing and subsequent language development.

2.2 Addressing Speaking Weaknesses Through Short-Consecutive Interpretation

Short-consecutive interpretation tasks foster meaningful learning by requiring active listening, message retention, and accurate reformulation (Laviosa, 2014). These cognitively demanding tasks engage learners in summarization, paraphrasing, and synthesis, drawing on attention and working memory (de Bruine et al., 2021; Patalano et al., 2006). Effective performance depends on learners' ability to manage linguistic and cognitive resources. Interpreting, viewed as a dynamic system (Dong, 2016), helps learners recognize communicative weaknesses (Yenkimaleki & Hosseini, 2023), though its role in improving EFL speaking awareness remains underexplored.

Communicative competence involves linguistic, discourse, strategic, and pragmatic skills (Celce-Murcia et al., 1995). Interpretation tasks activate these competencies in real-time, goal-oriented contexts, enhancing fluency, cohesion, and appropriateness. As such, interpretation serves not only as practice but as a catalyst for communicative development.

2.3 Reciprocal Peer Feedback and Retrospective Self-Reflection

Reciprocal peer feedback and self-reflection are key to second language development, linking the output and noticing hypotheses. Output promotes active use of language (Lightbown & Spada, 2013), while noticing involves conscious attention to form. Peer interaction supports both by offering opportunities to produce language, evaluate peers' performance, and reflect on form-focused input.

Although peer feedback research has often focused on writing (Kusumanigrum et al., 2019), its application to interpreting is growing. Holewik (2021) found that structured peer review in interpreter training fosters critical thinking and learner autonomy. The ATA (2022) likewise stresses detailed peer feedback to enhance spoken performance. Organized peer review using rubrics further improves grammatical competence (Okyar & Eksi, 2019; Singh & Tan, 2017).

In addition to peer review, self-reflection complements peer feedback by encouraging learner autonomy and metacognitive awareness. In interpreter education, recorded self-assessment helps learners identify strengths and weaknesses (Holewik, 2021; Trans-Int, 2017). Self-ratings often align with teacher assessments (Luoma & Tarnanen, 2003), though accuracy can vary by proficiency level (Cheng & Warren, 2005; Fujii & Mackey, 2009).

Pedagogical models integrating peer and self-feedback, such as cooperative interpreting tasks, promote iterative improvement and communicative competence (Atlantis Press, 2017). Together, these strategies build learner agency and support performance in both EFL and interpreting contexts.

3. Research Purpose and Questions

This study explores how tourism-focused interpretation tasks, combined with peer assessment and learner reflection, enhance spoken communicative competence among EFL university students. Grounded in the noticing hypothesis, it examines how learners detect and respond to linguistic gaps during real-time verbalization. While prior research has highlighted the challenges lower-proficiency learners face in identifying such gaps (e.g., Cheng & Warren, 2005; Fujii & Mackey, 2009), this study shifts focus to higher-intermediate students to offer a more nuanced understanding of noticing in developing spoken proficiency.

This study investigates whether students notice deficiencies and how reciprocal peer feedback supports this process. By comparing teacher and peer assessments, the study evaluates the reliability of peer judgment and identifies consistent patterns of communicative weaknesses. These insights help distinguish areas students can self-monitor from those requiring targeted instructional support. In addition, the study examines how students reflect on their perceived weaknesses after engaging in feedback and noticing practices. The research questions are:

1. How do peer and instructor evaluations of Chinese–English short-consecutive interpreting tasks compare in CEFR-based ratings?
2. What communicative competence weaknesses do student interpreters notice through peer feedback, and how are these reflected in their self-evaluations?

4. Method

This study examines how identifying deficiencies in Chinese–English short-consecutive interpreting enhances EFL learners' awareness of spoken communicative competence in a tourism context. It emphasizes the cognitive demands of producing L2 speech while processing

L1 input and highlights the role of peer assessment and self-reflection in helping learners notice and address communication gaps relevant to real-world tourism scenarios.

4.1 Participants

Thirty-two English-major juniors and seniors (25 female, 7 male) from a northern Taiwan university participated in this study. Half completed a Chinese-English interpreting task, while the other half served as peer raters; only the student interpreters' performances were analyzed. The interpreting group had an average TOEIC score of 706.24 (SD = 42.31), indicating CEFR B1-B2 proficiency. All participants had prior peer-rating experience from prerequisite sight translation courses.

4.2 Instruments

4.2.1 Review Rubrics

To assess the short consecutive interpreting task, both peers and instructors used CEFR-based rubrics focusing on communicative competence. The rubrics addressed five key categories drawn from CEFR guidelines and Savignon's (2017) framework:

Range. Use of varied vocabulary, grammar, and discourse features (linguistic/discourse competence).

Accuracy. Precision in language use with minimal errors (linguistic competence).

Fluency. Smooth, confident delivery (pragmatic/sociolinguistic competence).

Interaction. Effective language use in social exchanges (sociolinguistic/strategic competence).

Coherence. Logical and organized expression (discourse competence).

Although not task-specific, the rubrics were adapted to align with the ESP focus on tourism interpretation. Range assessed the ability to convey cultural and historical content, while Accuracy ensured meaning was correctly conveyed. Fluency, Interaction, and Coherence reflected the interpreter's ability to engage audiences and maintain narrative flow. These criteria represent core elements of ESP communicative competence (Athanasidou et al., 2016) and supported targeted evaluation of students' interpreting performance.

4.2.2 Self-reflection Through Watching Video-recording

To promote self-awareness, students reviewed video recordings of their in-class interpretations, captured using clip-on microphones. They were also asked to re-record their interpretations at home to experience the effect of noticing on performance improvement. To support structured reflection, the instructor provided guiding questions for written responses:

1. Did you notice any serious errors during interpretation? Include original and revised sentences.

2. How will you improve your speaking based on peer feedback?

This process encouraged students to identify weaknesses and actively apply feedback to enhance their communicative competence.

4.3 Instructional Design and Task Sequence

This study focused on tourism interpretation, aligning with calls for targeted language instruction in interpreter training (Cerezo, 2015; Cruz García & Adams, 2008; Malmkjær, 2004; Nord, 1997). The training task was designed within an English for Specific Purposes (ESP) framework, simulating authentic scenarios commonly encountered in the tourism industry. A travel manager from a Nordic tourism company was invited to deliver a promotional speech in Chinese. The study followed five main stages:

1. Preparation: Sixteen interpreting students were divided into four groups, each focusing on one theme related to Nordic travel: natural landscapes, activities, climate, or cuisine.
2. Interpretation Task: The manager gave a 90-minute Chinese speech, with students interpreting in short-consecutive mode. The session, including Q&A, lasted about 180 minutes. The speaker paused every 2-3 sentences, and students rotated every 10 minutes.
3. Peer Evaluation: Students were trained in CEFR-based rubrics prior to the task. During interpretation, two peers evaluated each interpreting student's performance.
4. Instructor Evaluation: Two experienced instructors also rated performances using the same rubric, based on video recordings.
5. Reflective Writing: Each interpreting student received their recording and completed guided reflections to identify errors and plan improvements.

4.4 Data Analysis: Peer, Instructor, and Self-Assessment of Interpreting Performance

Prior to the interpreting task, peer raters received CEFR-based evaluation rubrics and were assigned to assess two interpreters each, submitting two online ratings. The rubric included five categories: Range, Accuracy, Fluency, Interaction, and Coherence, rated on a 1-6 scale. Peer raters also provided one piece of constructive feedback targeting any of the five categories. Two experienced evaluators, the researcher and a language instructor, independently assessed all recorded interpretations using the same rubric. Inter-rater reliability, measured by Cohen's Kappa, indicated high agreement across all categories (Range: 0.89; Accuracy: 0.90; Fluency: 0.92; Interaction: 0.88; Coherence: 0.89).

A *t*-test was conducted to compare the mean scores from peer and instructor evaluations to identify any significant differences across categories. Following the task, student interpreters reviewed their recorded performances and submitted reflective self-evaluations. These reflections, along with peer comments, were coded using a thematic analysis approach adapted from Ryan and Bernard (2003). The analysis involved five steps: initial coding, labeling, theme generation, review, and interpretation. An instructor first coded 10% of the data to establish baseline consistency. The researcher and instructor then discussed and refined the coding scheme before applying it to the full dataset. Two rounds of discussion ensured consistency, resulting in high inter-coder reliability: 0.93 for peer comments and 0.91 for reflective writings.

5. Results

5.1 Comparing Peer and Instructor Evaluations

The first research question examined differences between peer and instructor ratings across five CEFR-based communicative competence categories: Range, Accuracy, Fluency, Interaction, and Coherence. The results showed no significant differences in the categories of Range, Accuracy, Fluency, and Interaction, indicating general alignment between peer and instructor assessments:

- Range: Peers ($M = 3.50$, $SD = 1.21$); Instructors ($M = 3.34$, $SD = 1.20$), $t(62) = 0.52$, $p = .608$
- Accuracy: Peers ($M = 3.81$, $SD = 1.28$); Instructors ($M = 3.44$, $SD = 1.07$), $t(62) = 1.27$, $p = .210$
- Fluency: Peers ($M = 3.78$, $SD = 1.43$); Instructors ($M = 3.75$, $SD = 1.41$), $t(62) = 0.09$, $p = .930$
- Interaction: Peers ($M = 3.28$, $SD = 1.27$); Instructors ($M = 3.22$, $SD = 1.31$), $t(62) = 0.40$, $p = .693$

However, a significant difference was found in the category of Coherence:

- Coherence: Peers ($M = 4.28$, $SD = 1.69$); Instructors ($M = 3.22$, $SD = 1.26$), $t(62) = -2.85$, $p = .006$, Cohen's $d = 0.72$. This medium effect size suggests that peers rated coherence more favorably than instructors. The finding highlights a potential discrepancy in evaluative standards, with instructors applying more critical judgment in assessing how students organized and connected ideas during interpretation.

5.2 Peer-Identified Areas of Deficiency

To address the second research question, peer comments were analyzed and coded according to CEFR criteria. A total of 32 comments were collected, referring to Range (10), Fluency (9), Accuracy (8), and Interaction (5); no comments addressed Coherence. All comments were originally written in Chinese, translated into English by the researcher, and checked by an instructor for accuracy. Table 1 summarizes the distribution of comment types and provides examples.

For Range, peer feedback indicated that limited lexical and structural range often resulted in overly literal translations, which reduced communicative naturalness. For example, Peer Rater 4 suggested revising “large-scale codfish trade” to “extensive trade of fish for cod” to achieve smoother delivery. The rater thought the interpreter had only one narrow way to express meaning, leading to literal or awkward output. This comment reflects an awareness by the Peer Rater 4 that effective interpreting requires flexible lexical choices and syntactic reorganization rather than direct word-for-word rendering.

Fluency issues were highlighted in cases of disrupted speaking flow. Peer Rater 5 observed that Student 9 experienced difficulties efficiently conveying the concept of “a trend toward economic liberalization.” The rater thought the issue arose from the interpreter's fixation on the specific term “liberalization,” which led to noticeable delays in the interpretation process. The rater believed the interpreter knew alternatives but couldn't deploy them efficiently, causing pauses or delays. A more effective approach, suggested by the rater, would have been to use the phrase “greater freedom,” which could have communicated the idea more swiftly and avoided keeping the audience waiting.

In Accuracy, tense errors were noted. Peer Rater 13 corrected the use of present tense in “Germany occupies Denmark...” to the appropriate past tense. Fluency issues included delayed delivery caused by lexical hesitation. Peer Rater 5 observed that Student 9 struggled with “economic liberalization,” recommending the more accessible phrase “greater freedom” to maintain flow.

In Interaction, Peer Rater 10 reported an instance in which a student interpreter failed to fully convey information about Icelandic cooking methods, mentioning only smoking while omitting other techniques such as fermentation. The interpreter did not seek clarification or request repetition from the speaker, which resulted in partial transmission of the message. This reflects a lapse in interactional competence as suggested by the rater, marked by the absence of clarification or meaning-negotiation strategies.

These comments reflect common weaknesses in student interpretation and demonstrate the depth of peer observations in assessing communicative performance.

Table 1
Deficiencies Identified from Peer Comments

Category	Type	Communicative competence	Total times of mentions	Weakness
Range	Incorrect use of lexis /or sentence patterns	Linguistic and discourse deficiency	10	word-for-word interpretation/Use the incorrect word
Accuracy	Grammar slips/or unclear content	Linguistic, sociolinguistic, and pragmatic deficiency	8	Use confusing grammar tense/ or the content lack clarity
Fluency	Silence or prolonged pauses	Linguistic, strategic deficiency	9	Hesitate too much that impedes communication
Interaction	Neglection to request further explanation	Sociolinguistic, strategic and pragmatic deficiency	5	Fail to seek clarification
Coherence	No mention			

5.3 Self-Reflective Evaluation

To explore areas for self-improvement, student interpreters reviewed recordings of their performances and submitted reflective writings. These reflections revealed key areas for development, some aligning with peer feedback but offering deeper insights into interpreting students' personal strategies for improving future interpretation performance (see Table 2). The analysis followed the communicative competence framework (Littlewood, 2011). The researcher and an instructor independently coded the reflections and resolved discrepancies through discussion to ensure consistency. Frequencies of identified areas were quantified and summarized in Table 2.

Table 2
Reported Enhanced Aspects in Communicative Competence from Self-reflection

Area of competency	Elements detailed in speaking performance	Frequency (Times of mention)	Percentage
Linguistic/Discourse	Use language accurately: select the correct vocabulary	20	25%
	Use language accurately: note sentence formation	19	23%
	Use language fluently: control speed and rhythm	14	17%
	Interact appropriately with the speaker (e.g., how to interrupt the speaker)	14	17%
Sociolinguistics/Pragmatics/ Strategic	Deal with the difficulties in	10	12%

Others	interpreting (e.g., utilize language strategies)	4	5%
	Develop public speaking skills (e.g., overcome fidgeting, speak audibly)		

Linguistic/Discourse Competency

Students' self-reflections revealed a strong emphasis in improving linguistic and discourse competence, particularly in vocabulary, grammar, and fluency. Vocabulary use was the most frequently cited area (20 mentions). Student 14 noted the need for greater lexical precision:

"I realized the need to refine my vocabulary for precision, which is essential for language professionals. For example, I missed 'latitude' in the sentence about Iceland's Northern Lights. The original was, 'Iceland is great for Northern Lights due to its location.' The improved version is, 'Iceland is ideal for Northern Lights because of its favorable location and high latitude.'"

Grammatical accuracy followed closely (19 mentions), with students identifying structural errors and proposing revisions. Student 3 reflected:

"I made significant grammatical errors. For example, I incorrectly said, 'There have a lot of tasty salmon, because Iceland is close to the Atlantic and Arctic Oceans.' Reflecting on this, I realize a better sentence would be, 'Nordic countries have a lot of tasty salmon because they are close to the Atlantic and Arctic Oceans.'"

Fluency (14 mentions) was a recurring challenge, particularly when interpreting dense content. Student 6 shared:

"Long sentences with multiple concepts disrupt my interpretative flow, causing frequent pauses. In interpreting 'Fjords are long, narrow bays from ancient glaciers with towering cliffs and blue waters,' I struggled with phrases like 'ancient glaciers' and 'towering cliffs,' leading to multiple stops and the speaker having to repeat in Chinese, which further hindered the flow."

These reflections demonstrate students' awareness of the key components required for effective bilingual communicative situations.

Student interpreters reported 28 instances related to challenges in interaction and strategy use, 14 involving help-seeking and 14 in clarifying messages. A key difficulty was knowing how to interrupt politely. As Student 1 noted:

"I lacked knowledge on how to politely interrupt the speaker. As she continued delivering messages that required clarification, I realized I faced difficulties."

Others emphasized the need for flexibility when conveying meaning under language constraints. Student 2 reflected:

"Being flexible is key when my language skills are limited. In interpretation, conveying the exact meaning is crucial and challenging. For instance, I could interpret 'the land of fire and ice, referring to Iceland's volcanoes, quite well. But I struggled with the detailed explanation of the 2010 Eyjafjallajökull eruption and its 'ash plume' affecting air travel. I resorted to a vague expression like 'the volcano

caused problems for airplanes.”

These reflections highlight the importance of adaptive communication and strategic choices in real-time communication.

Others

The student interpreters also reflected on their own delivery-related issues, particularly public speaking habits such as speaking too quickly or unclearly. Student 8 noted:

“As language workers, we must make sure our audience can easily follow what's being said. I've come to understand that my nervous habits, like fidgeting, don't come across well on stage.”

These insights emphasize the role of presentation skills in spoken proficiency.

6. Discussion and Implications

This study explored how task-based interpreting in a tourism setting, combined with peer assessment and self-reflection, supports EFL learners' development of spoken communicative competence. Interpreting a travel manager's speech in front of peers created an authentic, performance-based learning environment focused on identifying and addressing communication deficiencies.

6.1 Coherence: An Overlooked Competency

Findings revealed strong alignment between peer and instructor ratings in range, accuracy, fluency, and interaction. However, a notable discrepancy emerged in coherence, with instructors consistently assigning lower scores than peer raters. This divergence suggests that coherence, defined as the logical linking of ideas and the maintenance of narrative flow, was less salient to student evaluators, despite being a critical criterion in expert assessment.

Instructors' qualitative comments indicated frequent omissions in sequencing, temporal markers, and logical connectors, issues closely associated with short-term memory constraints and discourse organization during real-time processing (de Bruine et al., 2021). These patterns suggest that student interpreters tended to prioritize sentence-level accuracy and immediate meaning preservation over global discourse structuring. From an output-driven perspective, such reduced attention to coherence reflects a task-driven attentional trade-off under the cognitive and temporal demands of short-consecutive interpreting rather than a lack of awareness or competence. Similar patterns have been reported in EFL speaking contexts, where learners under high processing load allocate attentional resources to form and meaning at the expense of discourse-level organization (Okyar & Eksi, 2019).

Within this framework, the observed discrepancy does not imply that coherence is unteachable, but rather that it cannot be addressed through awareness-raising alone. Effective coherence instruction in interpreting must take cognitive demands into account and focus on reducing processing load during real-time performance. This can be achieved by teaching discourse organization through strategies such as routinized use of discourse markers, pre-structured narrative framing, and message-unit planning. By externalizing aspects of discourse management and minimizing on-the-spot organizational demands, learners are better able to sustain coherent delivery under time pressure. As Ibna Seraj and Hadina (2021) argue, coherent output enhances listener engagement and message effectiveness, making it a core competency for interpreters operating in authentic tourism settings.

Overall, embedding coherence-focused training within interpreting pedagogy enables students to better manage content organization, align with listener expectations, and handle extended discourse, thereby contributing to the development of holistic communicative competence beyond sentence-level accuracy.

6.2 Noticing Can Enhance Communicative Competence

This study highlights the importance of noticing in developing communicative competence during interpretation tasks. Drawing on Schmidt's (1993) theory, which distinguishes between basic noticing and deeper understanding, the findings show that learners must consciously recognize deficiencies to improve key skills: linguistic, discourse, sociolinguistic, pragmatic, and strategic. This supports prior research on the benefits of task-based training (Hilda & Pelokazi, 2023; Leaser, 2008; Nassaji, 2020).

Both peer assessment and self-reflection played a vital role. Peers identified performance gaps (Holt, 2015), while students' reflections revealed increased awareness and motivation to improve. These processes enriched learning, echoing Dutta, He, and Tsang's (2023) findings on reflective practice.

Consistent with Schmidt (1993), learners were able to identify several aspects of communicative competence. However, many focused on surface features, such as vocabulary and grammar while overlooking deeper cues like pragmatics (Lightbown & Spada, 2013). Peer comments referenced vocabulary issues 10 times, and reflections cited 20 instances of surface-level problems. As previous studies note (Cheng & Warren, 2005; Fujii & Mackey, 2009), even high-intermediate learners may struggle to notice less salient features, suggesting the need for instructional scaffolding tailored to individual noticing abilities.

7. Limitations

This study acknowledges several limitations. First, the short-consecutive interpreting format may not fully capture the interactive nature of natural L2 communication, such as spontaneous turn-taking in natural conversations. Second, while the rubric was detailed, its tourism-specific focus may not reflect all dimensions of communicative competence. Future research should consider integrating more objective assessments and refining ESP evaluation methods to better support L2 speaking development.

8. Conclusion

This study demonstrates the value of integrating peer assessment and self-reflection into short-consecutive interpretation tasks to enhance EFL learners' spoken communicative competence. By evaluating their own and peers' performances, interpreting students developed greater awareness of linguistic features, such as vocabulary, grammar, and word order, as well as sociolinguistic skills like attentive listening and clarification.

The findings also highlight the instructor's role in drawing attention to coherence, a key but often overlooked component of effective speech. Emphasizing coherence helps students structure messages clearly and improve overall communication. Finally, the study supports the use of task-based interpretation activities in university EFL classrooms. When combined with relevant ESP materials, such tasks can effectively promote both language development and real-world communication skills.

References

- Al-Harabsheh, A., Shehab, E., & Al-Rousan, R. (2020). Consecutive interpretation training: Challenges and solutions. *Journal of Foreign Language Teaching and Translation Studies*, 5(1), 85-102. <https://doi.org/10.22034/efl.2020.227897.1036>
- American Translators Association. (2022). Feedback: Going beyond “That was great”. <https://www.atanet.org/resources/feedback-going-beyond-that-was-great/>
- Atlantis Press. (2017). Cooperative interpreting learning based on peer and self-evaluation. *Social Science, Education and Humanities Research*, 133, 232-235. <https://www.atlantispress.com/article/25884328.pdf>
- Athanasίου, A., Constantinou, E. K., Neophytou, M., Nicolaou, A., Sophocleous, S. P., & Yerou, C. (2016). Aligning ESP courses with the Common European Framework of Reference for Languages. *Language Learning in Higher Education*, 6(2), 297-316. <https://doi.org/10.1515/cercles-2016-0015>
- Celce-Murcia, M., Dornyei, Z., & Thurrell, S. (1995). Communicative competence: A pedagogically motivated model with content specifications. *Applied Linguistics*, 6(2), 5-35. <https://doi.org/10.5070/L46200521>
- Cerezo Herrero, E. (2015). English language teaching for translators and interpreter trainees: Syllabus analysis and design. *Quaderns, Revista de Traducció*, 22, 289-306.
- Cheng, W., & Warren, M. (2005). Peer assessment of language proficiency. *Language Testing*, 22(1), 93-121.
- Christoffels, I. K., & de Groot, A. (2005). Simultaneous interpreting: A cognitive perspective. In J. F. Kroll & A. M. B. de Groot (Eds.), *Handbook of bilingualism: Psycholinguistic approaches* (pp. 454-479). Oxford University Press.
- Council of Europe/ALTE (2011). *Manual for language test development and examining. For use with the CEFR, Strasbourg: Language Policy Division*. www.coe.int/t/dg4/linguistic/ManualtLangageTest-Alte2011_EN.pdf
- Cruz García, L., & Adams, H. (2008). The role of foreign language teaching in the training of translators and interpreters. In I. Pascua Febles, M. Sarmiento Pérez, & B. Rey-Jouvin (Eds.), *Estudios de traducción, cultura, lengua y literatura: in memoriam Virgilio Moya Jiménez* (pp. 301-310).
- De Bruïne, A., Jolles, D., & Van den Broek, P. (2021). Minding the load or loading the mind: The effect of manipulating working memory on coherence monitoring. *Journal of Memory and Language*, 118, 104212. <https://doi.org/10.1016/j.jml.2020.104212>
- Dong, J. (2016). A dynamic systems theory approach to development of listening strategy use and listening performance. *System*, 63, 149-165.
- Dong, Y. (2018). Complex dynamic systems in students of interpreting training. *Translation and Interpreting Studies*, 13, 185-207.
- Dutta, S., He, M., & Tsang, D. C. W. (2023). Reflection and peer assessment to promote self-directed learning in higher education. *Journal of Educational Research and Reviews*, 11(3), 35-46. https://doi.org/10.33495/jerr_v11i3.23.111
- Fujii, A., & Mackey, A. (2009). Interactional feedback in learner-learner interactions in a task-based EFL classroom. *International Review of Applied Linguistics in Language Teaching*, 47(3), 267-301.
- Heilenman, L. K. (1991). *Self-assessment and placement: A review of the issues*. The American Association of University Supervisors, Coordinators and Directors of Foreign Languages Programs (AAUSC), 104-125.

- Holewik, A. (2021). Peer feedback and reflective self-assessment in public service interpreter training: A pilot study. *Zeszyty Prasoznawcze*, 64(4), 676-691.
<https://pdfs.semanticscholar.org/22e6/b85907a7a08003d7143b8135230572ecec11.pdf>
- Hilda, M. N., & Pelokazi, N. (2023). Enhancing communicative competence in English second language classrooms through traditional storytelling. *International Journal of Research in Business and Social Science*, 12(2), 376-383. <https://doi.org/10.20525/ijrbs.v12i2.2342>
- Holt, N. (2015). *Psychology: The Science of Mind and Behaviour* (3rd revised and updated ed.). McGraw-Hill Education.
- Ibna Seraj, P. M., & Hadina, H. (2021). A systematic overview of issues for developing EFL learners' oral English communication skills. *Journal of Language and Education*, 7(1), 229-240. <https://doi.org/10.17323/jle.2021.10737>
- Izumi, S. (2002). Output, input enhancement, and the noticing hypothesis: An experimental study on ESL relativization. *Studies in Second Language Acquisition*, 24, 541-577.
- Jingjing, X., & Fengying, M. (2015). A study into students' views on guided peer feedback in group work. *Chinese Journal of Applied Linguistics*, 38(2), 188-203.
- Kusumaningrum, S. R., Cahyono, B. Y., & Prayogo, J. A. (2019). The Effect of Different Types of Peer Feedback Provision on EFL Students' Writing Performance. *International Journal of Instruction*, 12(1), 213-224.
- Kitjaroochai, N. (2024). Exploring challenges and strategies in interpretation tasks among Thai EFL university students at an international university. *St. Theresa Journal of Humanities and Social Sciences*, 10(1). <https://so04.tcithaijo.org/index.php/stj/article/view/268688>
- Larsen-Freeman, D. (2018). Second language acquisition, WE, and language as a complex adaptive system (CAS). *World Englishes*, 37, 80-92.
- Laviosa, S. (2014). *Translation and Language Education: Pedagogic Approaches Explored*. Routledge.
- Lee, S., & Chang, S. (2005). Learner involvement in self-and peer-assessment of task-based oral performance. *Language Research*, 41(3), 711-735.
- Leeser, M. J. (2008). Pushed output, noticing, and development of past tense morphology in content-based instruction. *The Canadian Modern Language Review*, 65(2), 195-220.
- Li, Y., Li, W., & Sun, S. (2023). The application of input-output hypothesis in English listening teaching. *Lecture Notes in Education Psychology and Public Media*, 6(1), 222-228. <https://doi.org/10.54254/2753-7048/6/20220263>
- Lightbown, P. M. & Spada, N. (2013). *How languages are learned* (4th ed.). Oxford University Press.
- Littlewood, W. (2011). Communicative language teaching: An expanding concept for a changing world. In E. Hinkel (ed.), *Handbook of Research in Second Language Teaching and Learning, Volume II* (pp. 541-547), Routledge.
- Luoma, S., & Tarnanen, M. (2003). Creating a self-rating instrument for second language writing: From idea to implementation. *Language Testing*, 20(4), 440-465. <https://doi.org/10.1191/0265532203lt267oa>
- Malmkjaer, K. (Ed.). (2004). *Translation in undergraduate degree programs*. John Benjamins.
- Nakatani, Y. (2005). The effects of awareness-raising training on oral communication strategy use. *The Modern Language Journal*, 89(1), 76-91.
- Nation, I. S. P., & Newton, J. (2009). *Teaching ESL/EFL listening and speaking*. Routledge.
- Nord, C. (1997). *Translating as a Purposeful Activity. Functionalist Approaches Explained*. St. Jerome.

- Okyar, H., & Eksi, G. (2019). Training students in peer interaction and peer feedback to develop competence in L2 forms. *Journal of Language Teaching and Learning in Thailand*, 58, 62-94.
- Patalano, A. L., Chin-Parker, S., & Ross, B. H. (2006). The importance of being coherent: Category coherence, cross-classification, and reasoning. *Journal of Memory and Language*, 54(3), 407-424. <https://doi.org/10.1016/j.jml.2005.10.005>
- Ryan, G. W., & Bernard, H. R. (2003). Techniques to identify themes. *Field Methods*, 15(1), 85-109.
- Rotjanawongchai, S. (2024). Developing EFL university students' willingness to communicate and self-perceived communicative confidence through self-assessment of self-recorded conversations. *rEFLections*, 31(2), 639-669. <https://doi.org/10.61508/refl.v31i2.275092>
- Savignon, S. J. (2017). Communicative competence. In J. I. Lontas (Ed.), *The TESOL encyclopedia of English language teaching* (pp. 1-7). John Wiley & Sons. <https://doi.org/10.1002/9781118784235.eelt0047>
- Schmidt, R. (1993). Awareness and Second Language Acquisition. *Annual Review of Applied Linguistics*, 13, 206-226.
- Singh, K., & Tan, B. H. (2017). Effects of structured peer feedback on secondary school students' text revision. *Malaysian English Language Teaching Association*, 45(3), 126-143.
- Swain, M. (1985). Communicative competence: Some roles of comprehensible input and comprehensible output in its development. In S. Gass & C. Madden (Eds.), *Input in second language acquisition* (pp. 235-253). Newbury House.
- Swain, M. (2005). The output hypothesis: theory and research. In E. Hinkel (Ed.), *Handbook of research in second language teaching and learning* (pp. 471-483). Lawrence Erlbaum Associates.
- Trans-Int. (2017). Feedback on feedback: Exploring self-correction in interpreter education. *The Journal of Translation and Interpreting*, 9(2), 128-145. <https://www.trans-int.org/index.php/transint/article/view/640>
- Taras, M. (2002). Using Assessment for Learning and Learning from Assessment. *Assessment & Evaluation in Higher Education*, 27(6), 501-510.
- Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.
- Willis, D., & Willis, J. (2020). *Doing task-based teaching (2nd ed.)*. Oxford University Press.
- Yenkimaleki, M., van Heuven, V. J., & Hosseini, M. (2023). The effect of fluency strategy training on interpreter trainees' speech fluency: Does content familiarity matter? *Speech Communication*, 146, 1-10. <https://doi.org/10.1016/j.specom.2023.01.001>
- Zalbidea, J. (2021). On the scope of output in SLA: Task modality, salience, L2 grammar noticing, and development. *Studies in Second Language Acquisition*, 43(1), 50-82. <https://doi.org/10.1017/S02722263120000261>

The Affect Mechanism of AI Strategic Orientation on Aerospace Industry Enterprise Innovation Agility

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Abstract

Today, artificial intelligence technology determines the efficiency and sustainable development of corporate innovation, with AI strategic orientation closely linked to an enterprise's capacity for rapid and precise implementation of innovative outcomes. Consequently, this study employs knowledge management theory to investigate the relationship between AI strategic orientation and innovation agility within aerospace industry enterprises in Xi'an city, Shaanxi Province, China. It further examines the mediating role of collective intelligence and the moderating effect of sustainable leadership. Conducted in January 2026, this study employed purposive sampling and virtual questionnaires to collect data from employees across 19 aviation enterprises in Xi'an city, Shaanxi Province, China. A total of 1,039 valid questionnaires were received (yielding an 86.58% response rate). Utilising quantitative research methods, statistical techniques including correlation, mediation, moderation, and mediational moderation were applied to test the hypotheses. The results showed that the AI strategic orientation was positively correlated with innovation agility, and collective intelligence had a mediating effect, and sustainable leadership moderates the direct effect of AI strategic orientation on collective intelligence, and the indirect effects of sustainable leadership on collective intelligence through innovation agility within aerospace industry enterprises in Xi'an city, Shaanxi Province, China.

Keywords: AI Strategic Orientation; Innovation Agility; Collective Intelligence; Sustainable Leadership

1. Introduction

With the rapid advancement of new-generation digital technologies, artificial intelligence (AI) technology, as a quintessential frontier technology, is increasingly becoming a vital force driving economic and social development (Uriarte et al., 2026). Concurrently, the Chinese government has explicitly emphasized the significant role of AI technology in propelling economic and social progress, stressing the importance of deep integration between digital technologies, such as AI, and the real economy to facilitate industrial transformation and high-quality development (Liang et al., 2025). In recent years, AI technology has provided substantial support for enterprises to maintain competitive advantages in complex, dynamic

environments through its formidable computational power, data analytics capabilities, and automated decision-making (Haider et al., 2025a). Specifically, AI-driven intelligent decision-making, data empowerment, and resource optimisation enable businesses to perceive market shifts more rapidly, adjust strategic directions, and advance product innovation, thereby enhancing their innovation agility (Zhou et al., 2025). Concurrently, research indicates a positive correlation between AI adoption and organisational agility (Haider et al., 2025b). Furthermore, innovation agility represents an organisation's capacity to efficiently identify opportunities, respond swiftly to market demands, and effectively drive innovation outcomes amidst rapidly evolving market conditions and technological transformations (Zhou et al., 2025). Within technology-driven market environments, innovation agility has progressively become a critical capability for enterprises navigating digital transformation and global competition (Saegebrecht & Walter, 2025). However, the application of emerging technologies often entails complexity and uncertainty. The deployment of AI technologies does not necessarily guarantee improvements in corporate performance or agility; it necessitates careful consideration of the alignment between technology and organisational context (Uriarte et al., 2026). For instance, IBM Watson Health sought to reshape the healthcare industry through AI, yet the project ultimately failed due to neglecting the complexity of industry knowledge and practices (George, 2025). Consequently, how to embed AI within corporate strategic planning to achieve alignment between strategic direction and technological application, thereby enhancing organisational innovation agility, remains an unresolved challenge.

Historically, strategic orientation has served as a fundamental principle guiding corporate actions and resource allocation, significantly influencing the formation of competitive advantage (Larabi, 2025). As AI technology deepens its practical application within corporate management, related research has gradually shifted paradigms from 'technological attributes' towards 'strategic attributes'. Early studies primarily explored AI infrastructure investment, technological application, and the resulting technological value (Murphy, 2025). In recent years, scholars have increasingly focused on AI-driven strategic reconfiguration processes, proposing that AI strategic orientation should encompass multiple dimensions, including technological embedding, data-driven decision-making, and organisational adaptability (Haider et al., 2025b). As an emerging research concept, AI strategic orientation is defined as the systematic strategic choices enterprises make around AI technology. By integrating AI capabilities with corporate resources, it empowers comprehensive business optimisation and breakthroughs in technological innovation (Zhou et al., 2025). Furthermore, existing research on AI strategic orientation primarily focuses on two aspects: firstly, analysing its conceptual underpinnings, highlighting that it manifests not only as directional choices in technological investment and application but also in how enterprises deeply integrate AI with core business processes to drive efficient innovation activities (Haider et al., 2025a); Secondly, analyses of the operational mechanisms of AI strategic orientation, examining its multifaceted impacts on corporate performance, environmental protection behaviours, and other domains (Haider et al., 2025b). Overall, existing research on AI strategic orientation remains nascent and fragmented, making it challenging to comprehensively unravel the operational mechanisms of its black box (Jalil et al., 2025). Notably, the pathway mechanisms through which AI technology enhances corporate innovation agility—distinct from perspectives centred on technological application—remain unclear, necessitating further research advancement.

On the other hand, knowledge management theory indicates that an organisation's

innovation capability relies heavily on knowledge sharing and application (Phelps et al., 2012). Against the backdrop of rapid AI technological advancement, the methods, mechanisms, and pathways of knowledge management are transforming. How enterprises can enhance innovation agility through effective knowledge management has become a central concern in both theory and practice. Concurrently, research indicates that knowledge sharing moderates the relationship between AI strategy alignment and organisational agility (Zhou et al., 2025). However, while existing studies have examined the role of knowledge management in corporate innovation, scant attention has been paid to the contributions of team members through collaboration, communication, and knowledge sharing (Abdulmuhsin et al., 2025), nor to how this process influences organisational innovation agility. Notably, as a core component of knowledge management, collective intelligence reflects the team-level cognitive capacity through which members jointly tackle complex tasks or resolve problems via information dissemination, inclusive decision-making, and team learning. It effectively breaks down information silos, drives cross-departmental and cross-level knowledge collaboration, and manifests as a knowledge input mechanism (Bonnaventure et al., 2025). Simultaneously, it represents the core dynamic process of corporate knowledge management, offering a crucial perspective for understanding dynamic knowledge management models in the AI era (Chu et al., 2026). Supported by an AI strategic orientation, AI technology continuously interacts and deepens with corporate knowledge management activities, strategies, and capabilities. The development process of collective intelligence is continually reshaped, gradually forming a new knowledge management system underpinned by AI. However, existing research primarily focuses on AI technology applications in knowledge acquisition and data analysis, leaving unresolved whether AI strategic orientation can further shape organisational innovation agility through collective intelligence. Therefore, this study, grounded in knowledge management theory, examines how AI strategic orientation drives organisational innovation agility via collective intelligence. It seeks to construct a more systematic and dynamic theoretical framework, thereby expanding the application boundaries of knowledge management theory within digital transformation contexts.

Moreover, the formulation and implementation of corporate strategy heavily depend on leadership. In establishing and executing an AI strategic orientation, sustainable leadership may prove a pivotal factor. This refers to leaders balancing long-term development while managing pressures from short-term objectives and immediate organisational demands (Lewandowska et al., 2023). It may steer the direction and execution intensity of AI strategic orientation, while also indirectly influencing strategic resource allocation and organisational acceptance and adaptability towards new technologies – that is, the corporate knowledge management process (Aldighrir, 2024). Concurrently, research indicates that leadership moderates the relationship between AI strategy and corporate agility (Zhong et al., 2026). Thus, leaders' receptiveness to new technologies, strategic execution capabilities, and cultural orientation shaping can indirectly influence the effectiveness of corporate AI strategic planning and agility. However, whether sustainable leadership can foster the relationship between AI strategic orientation and collective intelligence remains unknown. Therefore, it is necessary to further clarify the moderating effect of sustainable leadership on how AI strategic orientation impacts the corporate knowledge management process.

With the rapid advancement of science and technology in the aerospace sector, humanity's capacity to access, utilise, and explore space has been further enhanced (Sun et al., 2025).

Presently, economic and social development increasingly relies upon space assets, with national interests comprehensively extending into the cosmic domain. Outer space has thus become a strategic high ground fiercely contested by nations worldwide. Leading international satellite enterprises are actively investing in space internet services, striving to dominate satellite network infrastructure and secure precious celestial resources. Large-scale low-earth orbit constellation projects, exemplified by Starlink, have now entered the deployment phase (Sun et al., 2025). Concurrently, the world is undergoing a profound and extensive digital revolution. Digital technologies such as artificial intelligence, big data, and cloud computing are accelerating innovation, integrating more deeply into all sectors of the economy and society, and permeating the entire development process. Intelligence has become a pivotal force in restructuring global resources, reshaping international competitive landscapes, and building new productive forces (Uriarte et al., 2026). However, previous research has scarcely explored aerospace enterprises, failing to advance practical development. Therefore, this study will investigate the mechanisms influencing innovation agility within Chinese aerospace enterprises, aiming to enhance related fields.

In summary, this research seeks to examine, from a Chinese perspective, aerospace employees' perceptions of AI strategic orientation and corporate innovation agility, alongside the mediating and facilitating effects of collective intelligence and sustainable leadership. Clarifying these relationships will not only deepen theoretical understanding of how AI strategic orientation empowers innovation agility in aerospace enterprises and expand the interdisciplinary field between knowledge management theory and digital strategy research, but also provide practical pathways for enterprises to optimise knowledge management processes and enhance innovation agility during AI-driven strategic implementation.

2. Literature Review and Hypothesis Development

2.1 Knowledge Management Theory

An organisation's capacity for innovation relies heavily on its ability to acquire and manage knowledge (Phelps et al., 2012). Consequently, this study defines AI strategic orientation as the systematic strategic choices an enterprise makes concerning AI technology. By integrating AI capabilities with corporate resources, this orientation enables comprehensive business optimisation and breakthroughs in technological innovation (Zhou et al., 2025), categorising it as knowledge integration and application. Conversely, this study defines collective intelligence as the team-level cognitive capability whereby members collectively address complex tasks or resolve problems through information dissemination, inclusive decision-making, and team learning (Bonnaventure et al., 2025). It also represents the core dynamic process of corporate knowledge management and is categorised as part of the knowledge acquisition process. Furthermore, this study defines sustainable leadership as the capacity of leaders to balance short-term objectives and immediate organisational demands while prioritising long-term development (Lewandowska et al., 2023). It may influence the direction and execution intensity of AI strategy, while also indirectly affecting strategic resource allocation and organisational acceptance and adaptability towards new technologies – that is, the corporate knowledge management process. Consequently, leaders' acceptance of new technologies, strategic execution capabilities, and organisational culture shaping directly impact corporate AI strategic planning and innovation outcomes. Hence, this study classifies it as a knowledge management process. Furthermore, this study defines innovation agility as an

organisation's capacity to efficiently identify opportunities, respond swiftly to market demands, and effectively drive innovation outcomes amidst rapidly changing market environments and technological transformations (Zhou et al., 2025), classifying it as an organisational capability.

Consequently, AI strategic orientation (knowledge integration and application) interacts with collective intelligence (the knowledge acquisition process) and sustainable leadership (the knowledge management process) to influence organisational innovation agility (organisational capability).

2.2 AI Strategic Orientation and Innovation Agility

In the highly dynamic and competitive external environment of the digital age, innovation agility has become pivotal for enterprises to sustain competitive advantage (Haider et al., 2025a). However, traditional corporate innovation models often constrain the speed and quality of innovation responses due to issues such as poor information flow, lengthy decision-making chains, and inefficient resource allocation (Liang et al., 2025). The introduction of AI strategic orientation offers enterprises a novel pathway to overcome these constraints, significantly enhancing innovation agility through technological empowerment. AI strategic orientation denotes systematic strategic choices centred on AI technology, integrating AI capabilities with corporate resources to drive comprehensive business optimisation and technological breakthroughs (Zhou et al., 2025). Mirroring the proactive and risk-bearing nature of traditional strategic approaches, this orientation emphasises enterprises' deliberate adoption, deployment, and utilisation of AI to achieve long-term objectives. Unlike conventional strategic orientations or technology adoption strategies, AI strategic orientation exhibits characteristics of technological foresight, dynamism, and integration. Particularly within complex and volatile market environments, it effectively enhances corporate responsiveness and innovation agility (Haider et al., 2025b). Concurrently, research indicates a positive correlation between AI adoption and organisational agility (Haider et al., 2025b). Consequently, the AI strategic orientation serves not only as a pivotal pathway for integrating technology and business operations but also as a critical strategy for driving innovation agility and sustaining competitive advantage amidst uncertainty. It is assumed that:

H1: AI strategic orientation and innovation agility are positively correlated.

2.3 The Moderator Role Played by Collective Intelligence

Against the backdrop of deep integration between artificial intelligence technology and management strategy, knowledge sharing, communication, and collaboration not only facilitate the flow of knowledge within organisations but also maximise the efficacy of AI-driven strategic direction, thereby enhancing corporate innovation agility. In this regard, collective intelligence—as a process of knowledge acquisition—may serve as a bridge between AI strategic orientation and organisational innovation agility. Concurrently, research indicates that knowledge sharing moderates the relationship between AI strategic orientation and organisational agility (Zhou et al., 2025). Consequently, collective intelligence is described as the team-level cognitive capability through which members jointly tackle complex tasks or resolve problems via information dissemination, inclusive decision-making, and team learning. It effectively dismantles information silos, facilitates cross-departmental and cross-level knowledge collaboration, and manifests as a 'knowledge input' mechanism (Bonnaventure et al., 2025). This arises from AI technology's facilitation of convenient and intelligent knowledge sharing. Through automated knowledge integration, semantic analysis, and natural language processing, AI enhances the ease of corporate knowledge exchange. This technological

advancement effectively dismantles information barriers between departments and teams, thereby accelerating knowledge flow and dissemination (Abdulmuhsin et al., 2025). Therefore, in terms of the knowledge acquisition process, AI accelerates the speed of corporate knowledge acquisition and integration. This enables enterprises to respond swiftly to market changes while enhancing organisational learning capabilities, making innovation activities more efficient and precise. It is assumed that:

H2 :Collective intelligence has a mediating effect between the AI strategic orientation and innovation agility.

2.4 The Moderator Role Played by Sustainable Leadership

Sustainable leadership refers to the capacity of leaders to balance long-term development while managing the pressures of short-term objectives and immediate organisational demands (Lewandowska et al., 2023). It requires leaders not only to possess traditional management skills but also to recognise the potential of technological change and drive the introduction and application of new sustainable technologies. The implementation of an AI strategy requires the integration and coordination of resources both within and outside the organisation. Sustainable leadership may directly and indirectly influence the effectiveness of strategic execution by providing strategic direction and behavioural norms for innovation in sustainable technologies. Concurrently, research indicates that leadership can moderate the relationship between AI strategy and organisational agility (Zhong et al., 2026). Thus, sustainable leadership—as a contemporary leadership paradigm—not only shapes innovation-driven organisational strategies but also influences knowledge management activities within AI strategy implementation (Aldighrir, 2024), such as collective intelligence. Consequently, this culture reduces employee resistance to AI strategy deployment, enhances acceptance of technological applications, and stimulates innovation and agility within knowledge-sharing, communication, and collaborative processes. It is assumed that:

H3: Sustainable leadership has a positive moderating effect on AI strategic orientation and collective intelligence.

On further analysis, sustainable leadership moderated the relationship between AI strategic orientation and collective intelligence, as well as the relationship between AI strategic orientation and innovation agility, and the present study hypothesized that the mediating role of collective intelligence between AI strategic orientation and innovation agility was also moderated by sustainable leadership. It is assumed that:

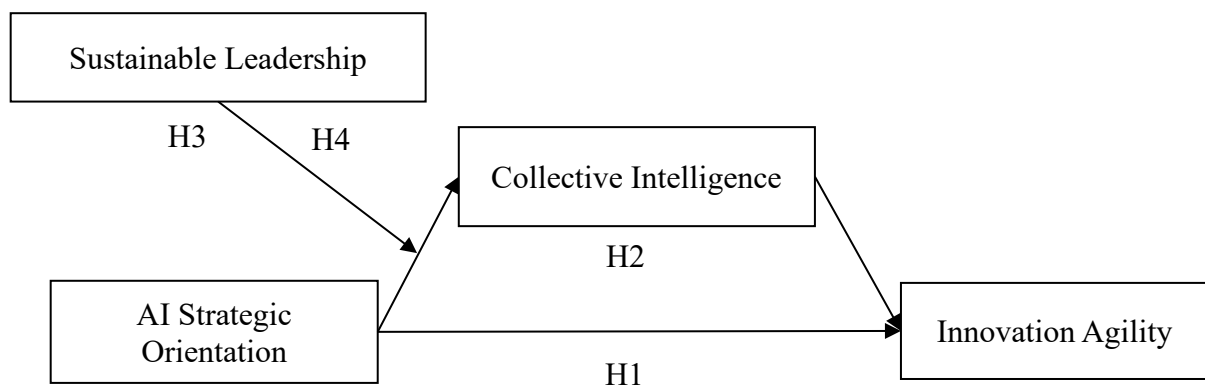
H4: Sustainable leadership moderates the indirect effect of AI strategic orientation and innovation agility, i.e., the higher the level of sustainable leadership, the higher the indirect effect of AI strategic orientation and innovation agility through collective intelligence.

3. Methodology

3.1 Research Framework

The research framework was constructed according to the research objectives and hypotheses (Figure 1).

Figure 1
Research Framework



3.2 Samples and Procedures

This study was conducted in January 2026, employing purposive sampling and utilising an online questionnaire to survey employees from 19 aerospace industry enterprises in Xi'an, Shaanxi Province, China. The objective was to assess their perceptions regarding AI strategic orientation, collective intelligence, sustainable leadership, and corporate innovation agility. The final sample comprised 1,039 responses (validity of 86.58%).

3.3 Measures

AI strategic orientation scale :Designed by Zhou et al. (2025), a single-factor with 7 items (Cronbach's $\alpha=0.974$).

Collective intelligence scale: Designed by Bonnaventure et al. (2025), information sharing, inclusive decision-making, team learning 3 factors with 12 items (Cronbach's $\alpha=0.92$).

Sustainable leadership scale : Designed by Lewandowska et al .(2023), a single-factor with 10 items (Cronbach's $\alpha=0.908$).

Innovation agility scale: Designed by Zhou et al. (2025), a single-factor with 5 items (Cronbach's $\alpha=0.876$).

Gender, age, and household registration category were used as demographic variables, while other variables were measured by the 5-point method and self-reported.

4. Results

4.1 Distribution of Population Characteristics

As shown in Table 1, the sample was predominantly male (708, 68.14%), with the highest percentage of with the highest percentage of entrepreneurs in the age group of 22-30 years old (325, 31.28%) in the age group of 31-40 years old (310, 29.84%), and with the proportion of employees with rural household registration was the highest (659, 63.43%).

Table 1*Distribution of Population Characteristics*

Background Variables	Category	N	%
Gender	Male	708	68.14
	Female	331	31.86
Age	22-30	167	16.07
	31-40	310	29.84
	41-50	325	31.28
	51 and above	237	22.81
Household registration category	Rural	659	63.43
	Urban	380	36.57

Note: n=1,039.

4.2 Model Fit

As shown in Table 2, the SRMR of the whole model is 0.04, and a good match.

Table 2*Root Mean Square Error*

	O	M	95%	99%
Saturated model	0.04	0.032	0.036	0.038
Estimated model	0.04	0.032	0.036	0.038

Note: n=1,039.

4.3 Correlation Analysis

As shown in Table 3, the correlation matrix shows that the AI strategic orientation is positively correlated with innovation agility ($r=0.245^{***}$, $p<0.05$), and H1 holds.

Table 3*Correlation Analysis*

Variables	1	2	3	4
1. AI strategic orientation	0.745			
2. Collective intelligence	0.481**	0.732		
3. Sustainable leadership	0.232**	0.228**	0.721	
4. Innovation agility	0.245**	0.239**	0.257**	0.746
M	3.90	3.84	3.95	3.96
SD	0.92	0.96	1.02	0.95
Cronbach's α	0.886	0.875	0.811	0.883
CR	0.613	0.672	0.714	0.758
AVE	0.556	0.536	0.521	0.557

Note: $*$ = $p<0.05$.

4.4 Moderating and Moderating Effect

As shown in Table 4, the collective intelligence had a mediating effect (0.258^{***} , $p<0.05$) on the path of AI strategic orientation to innovation agility, and H2 hold; the sustainable leadership has a significant positive moderating effect in the pathway AI strategic orientation to the collective intelligence (0.136^{***} , $p<0.05$), and H3 holds.

Table 4
Moderating and Moderating Effect

Effect	Path	Coefficients
Mediating	AI strategic orientation → collective intelligence → innovation agility	0.258*** (Sobel Z)
Moderating	AI strategic orientation × sustainable leadership → collective intelligence	0.136***

Note: * = $p < 0.05$.

4.5 Moderated Mediation Effect

As shown in Table 5, the indirect effect of sustainable leadership through collective intelligence was significant at different levels of sustainable leadership (0.1132***, 0.1436***, 0.1582***, $p < 0.05$), and H4 holds.

Table 5
Test Results of Moderated Mediation Effect

Effect	Sobel test		95 IC
	Indirect effect	SE	
Sustainable leadership(low)	0.1132	0.0327	0.1366, 0.3051
Sustainable leadership(medium)	0.1436	0.0381	0.1734, 0.3578
Sustainable leadership(high)	0.1582	0.0524	0.1803, 0.4332

Note: * = $p < 0.05$.

5. Conclusion

5.1 Conclusion and Discussion

Research findings indicate that AI strategic orientation exhibits a positive correlation with corporate innovation agility. This stems from AI technology not only enhancing aerospace industry enterprises' speed of perceiving external innovation opportunities and strengthening their innovation capabilities, but also driving organisational structural and business model transformations through continuous learning and real-time adjustments. This enables enterprises to rapidly adapt to market environment shifts and advance the implementation of innovation outcomes (Haider et al., 2025a), thereby elevating innovation agility. Consequently, AI strategic orientation significantly enhances corporate innovation agility, representing not merely a technological choice but a pathway for building organisational capability.

Findings indicate that collective intelligence mediates the relationship between AI strategic orientation and innovation agility. Such knowledge dissemination, sharing, and learning activities not only facilitate collaborative innovation across different departments and teams within aerospace industry enterprises, shortening the time cycle from knowledge generation to application, but also enhance the enterprise's adaptability to environmental changes. Furthermore, they promote the accumulation of dynamic capabilities, supporting sustained innovation in volatile environments (Bonnaventure et al., 2025). Thus, the application of AI technologies renders the overall knowledge management environment intelligent, making knowledge acquisition, organisation, sharing, and application more efficient. Consequently, collective intelligence is a core element for realising AI strategy empowerment. Enterprises should enhance organisational knowledge flow and reconfiguration capabilities by optimising internal knowledge management systems.

Findings indicate that sustainable leadership positively moderates the beneficial impact of AI strategic orientation on collective intelligence. In advancing AI strategy implementation, aerospace industry enterprises must prioritise cultivating leaders possessing a sustainable vision and long-term perspective to enhance strategic execution efficiency and collective knowledge efficacy (Aldighrir, 2024). This is because, under the framework of AI strategic orientation, aerospace enterprises can continuously adjust and optimise the allocation of knowledge resources to respond to technological transformations and market dynamics (Zhong, Ady, & Indrasari, 2026). Concurrently, an enterprise's adaptability and innovation capacity within competitive environments depend upon collective intelligence, involving the integration, restructuring, and application of both internal and external knowledge resources. Consequently, collective intelligence not only determines whether an enterprise can efficiently utilise existing knowledge but also influences how aerospace industry enterprises rapidly adjust their knowledge structures to support enhanced innovation agility. Moreover, the research findings not only validate the pivotal role of AI strategic orientation in innovation-driven processes but also further reveal the bridging function of knowledge management within this framework. They additionally highlight the indirect facilitative role of sustainable leadership in amplifying the positive impact of AI strategy on corporate innovation agility.

5.2 Contributions

First, this study examines how AI technology is embedded within corporate strategy and influences the enhancement of innovation agility in China's aerospace industry enterprises from a strategic orientation perspective, addressing two gaps in existing research. (1) The adoption of AI technology is not achieved overnight; it requires strategic guidance at the corporate level and organizational adaptation mechanisms. (2) Despite AI's pervasive penetration into corporate operations and management, systematic theoretical exploration remains scarce regarding how enterprises formulate and execute AI-driven strategies. This study employs the concept of AI strategic orientation to reveal its mechanism of mediating innovation agility through collective intelligence. It provides a theoretical framework for understanding how AI transcends the technological level to reach the organizational strategic level, enriching the application of strategic orientation theory in the context of digital transformation. Simultaneously, it unveils the systematic process of knowledge—from acquisition and flow to integration, reorganization, and ultimately innovation transformation—under AI technology. This research expands the boundaries of knowledge management theory, offering a new theoretical perspective for understanding AI-enabled knowledge management models and providing guidance for enterprises to optimize knowledge management practices in digital environments.

Second, it enriches the theoretical perspective on sustainable leadership in technology-driven strategy implementation, revealing its mediating role in the relationship between AI strategic orientation and collective intelligence. In recent years, sustainable leadership has emerged as a key driver of organizational transformation. However, existing research primarily focuses on its impact on corporate performance or employee behavior, with limited exploration of its role in strategic orientation and innovation mechanisms. Therefore, this study examines sustainable leadership from the perspective of AI strategy implementation, revealing its crucial moderating effect on the relationship between AI strategic orientation and collective intelligence.

Furthermore, the study confirms that managers possessing long-term perspective leadership can more effectively drive AI strategy implementation, foster knowledge acquisition

and management processes, and enhance organizational knowledge fluidity and agility. This finding not only expands the research scope of sustainable leadership but also underscores the strategic guiding role of leaders in transformation. It provides new theoretical support for optimizing leadership development in China's aerospace industry enterprises engaged in AI-driven innovation practices.

5.3 Recommendations

This study offers recommendations for the practices of China's aerospace industry enterprises.

Firstly, Chinese aerospace enterprises should incorporate AI technology application into their long-term strategic planning, establishing a strategic orientation system centred on AI capabilities. Management should prioritise embedding AI functionalities within core operational processes to enhance business agility and meet rapidly evolving market demands. Additionally, cross-departmental coordination mechanisms must be established to ensure effective top-down implementation of AI strategies across all operational tiers.

Secondly, further drive the overall upgrade and transformation of knowledge acquisition and management within China's aerospace industry enterprises. On one hand, optimise mechanisms for knowledge dissemination, sharing, and learning to promote knowledge flow and integration among employees. For instance, establishing digital knowledge management platforms enables efficient storage and dynamic distribution of knowledge, ensuring knowledge resources are fully utilised within the organisation and remain highly aligned with corporate strategic objectives. Particularly within AI-driven dynamic environments, enterprises can leverage intelligent tools to screen and prioritise knowledge resources, thereby optimising resource allocation and enhancing the precision of innovation-related decision-making.

Finally, it is crucial to enhance managers' sustainable leadership capabilities to support AI strategy implementation and knowledge management transformation. China's aerospace industry enterprises should strengthen the cultivation of sustainable thinking and AI application capabilities among managers, enabling them to effectively drive AI strategy implementation and knowledge management model transformation. Managers must foster an innovation-oriented culture within the enterprise, encouraging staff to embrace technological change. By establishing clear performance objectives and incentive mechanisms, they should guide employees to actively participate in knowledge dissemination, sharing, and learning activities, thereby advancing the development of the enterprise's innovation agility.

5.4 Limitations and Future Research Directions

Although this study offers a novel theoretical framework and empirical analysis by examining the interactive mechanisms among variables such as AI strategy orientation, collective intelligence, sustainable leadership, and innovation agility, several limitations warrant further exploration and refinement in future research.

First, the regional constraints of the sample limit the broad applicability of the findings. The sample data primarily originates from aerospace enterprises in Xi'an, Shaanxi Province, China. Particularly within specific cultural contexts and management practices, the findings may predominantly reflect characteristics of Chinese aerospace enterprises operating under particular institutional and market conditions. Future research could validate and broaden the generalizability of these conclusions by incorporating international samples to compare similarities and differences in the relationship between AI strategic orientation and innovation agility across enterprises in various countries and regions.

Second, while this study examines the role of collective intelligence as a mediating variable from a knowledge management perspective, other potential mediators—such as knowledge networks, organizational fault-tolerant perception, and human-AI collaboration—have not been incorporated into the analytical framework. For instance, the complexity and breadth of knowledge networks may further elucidate how AI strategic orientation achieves innovation agility through external collaboration and resource integration.

Third, this study insufficiently accounts for the impact of industrial/sector characteristics and firm attributes on research findings. Significant differences exist across industries and sectors in technological development trajectories, competitive environments, and resource allocation—factors that may substantially influence the effectiveness of AI strategic orientation implementation and its underlying mechanisms for fostering innovation agility. For instance, manufacturing and services exhibit fundamental differences in technological application complexity and innovation demands, yet the study did not delve into intersectoral variations. Furthermore, enterprises of varying scales, developmental stages, and technological capabilities may exhibit substantial differences in their reliance on AI strategic orientation and implementation pathways. Future research should strengthen sector-specific and firm-characteristic analyses, providing more targeted theoretical support and practical guidance for management practices across diverse contexts.

Fourth, the research methodology also exhibits certain limitations. This study primarily relies on cross-sectional survey data. While statistical methods validated the hypothesized model, it remains insufficient in analyzing variable causality and dynamic changes—such as the dynamic evolution of corporate AI strategic orientation, the application level of AI technologies, and the hierarchical dimensions of sustainable leadership. Future research could adopt longitudinal designs to collect panel data, capturing the dynamic impact of AI strategic orientation on corporate innovation agility. Additionally, integrating case studies or experimental research would enable deeper exploration of how AI strategic orientation influences knowledge management and innovation practices within specific contexts, thereby enhancing the persuasiveness and practical relevance of research conclusions.

References

- Abdulmuhsin, A. A., Hussein, H. D., AL-Abrow, H., Masa'deh, R. E., & Alkhwalid, A. F. (2025). Impact of artificial intelligence and knowledge management on proactive green innovation: The moderating role of trust and sustainability. *Asia-Pacific Journal of Business Administration*, 17(3), 765-795. <https://doi.org/10.1108/APJBA-05-2024-0301>
- Aldighrir, W. M. (2024). Impact of AI ethics on school administrators' decision-making: The role of sustainable leadership behaviors and diversity management skills. *Current Psychology*, 43(41), 32451-32469. <https://doi.org/10.1007/s12144-024-06862-0>
- Aubouin-Bonnaventure, J., Chevalier, S., Morel, N., Gillet, N., & Fouquereau, E. (2025). Collective intelligence in work teams: A new multilevel construct and scale. *Current Psychology*, 44(11), 10375-10391. <https://doi.org/10.1007/s12144-025-07818-8>
- Chu, G., Wang, Z., Hu, J., & Zhan, P. (2026). Collective intelligence: Conceptualization, mechanism, and measurement. *Chinese Journal of Advances in Psychological Science*, 34(3), 515-526. <https://doi.org/10.3724/SP.J.1042.2026.0515>
- George, A. S. (2025). Transforming healthcare with artificial intelligence: Strategies, insights, and frameworks for innovation. *Partners Universal International Research Journal*, 4(2), 48-78. <https://doi.org/10.5281/zenodo.15685381>

- Haldar, U., Alam, G. T., Rahman, H., Miah, M. A., Chakraborty, P., Saimon, A. S. M., ... & Manik, M. M. T. G. (2025a). AI-driven business analytics for economic growth leveraging machine learning and MIS for data-driven decision-making in the US economy. *Journal of Posthumanism*, 5(4), 932-957. <https://doi.org/10.63332/joph.v5i4.1178>
- Haider, H. A., Naseer, A., Tanveer, M., Imran, M., Siddique, F., & Razaq, N. (2025b). Integrating artificial intelligence into strategic decision-making: Implications for organizational agility and innovation. *Advance Journal of Econometrics and Finance*, 3(1), 135-140. <https://doi.org/10.63075/0cvckv13>
- Jalil, M. F., Lynch, P., Marikan, D. A. B. A., & Isa, A. H. B. M. (2025). The influential role of artificial intelligence (AI) adoption in digital value creation for small and medium enterprises (SMEs): Does technological orientation mediate this relationship?. *AI & Society*, 40(3), 1875-1896. <https://doi.org/10.1007/s00146-024-01969-1>
- Larabi, C. (2025). The role of innovation capability and strategic orientation to achieve competitive advantage: The mediating effect of strategic renewal in SMEs. *Journal of Strategy and Management*, 18(4), 821-848. <https://doi.org/10.1108/JSMA-07-2025-0287>
- Lewandowska, A., Ullah, Z., AlDhaen, F. S., AlDhaen, E., & Yakymchuk, A. (2023). Enhancing organizational social sustainability: Exploring the effect of sustainable leadership and the moderating role of micro-level CSR. *Sustainability*, 15(15), 1-16. <https://doi.org/10.3390/su151511853>
- Liang, H., Fan, J., & Wang, Y. (2025). Artificial intelligence, technological innovation, and employment transformation for sustainable development: Evidence from China. *Sustainability*, 17(9), 1-28. <https://doi.org/10.3390/su17093842>
- Murphy, L. (2025). The productivity dilemma: Examining the truth behind automation's impact on employment, and the mediating role of augmentation. *International Journal of Organizational Analysis*, 33(3), 622-644. <https://doi.org/10.1108/IJOA-04-2024-4430>
- Mueller-Saegebrecht, S., & Walter, A. T. (2025). Strategic agility-an urgent capability for successful business model innovation? A conceptual process model and theoretical framework. *Strategic Change*, 34(3), 407-428. <https://doi.org/10.1002/jsc.2645>
- Phelps, C., Heidl, R., & Wadhwa, A. (2012). Knowledge, networks, and knowledge networks: A review and research agenda. *Journal of management*, 38(4), 1115-1166. <https://doi.org/10.1177/0149206311432640>
- Sun, P., Yuan, W., Sun, F., Shi, Q., Shi, S., & Wang, G. (2025). Digital transformation strategy of aerospace industry. *Chinese Journal of Strategic Study of CAE*, 27(2), 216-229. <https://doi.org/10.15302/J-SSCAE-2025.01.022>
- Uriarte, S., Baier-Fuentes, H., Espinoza-Benavides, J., & Inzunza-Mendoza, W. (2026). Artificial intelligence technologies and entrepreneurship: A hybrid Literature review. *Review of Managerial Science*, 20(1), 251-299. <https://doi.org/10.1007/s11846-025-00839-4>
- Zhou, Y., Zhou, D., & Lu, R. (2025). How AI strategic orientation empowers enhancement of enterprise innovation agility? -Based on knowledge management perspective. *Chinese Journal of R&D Management*, 37(6), 150-163. <https://doi.org/10.13581/j.cnki.rdm.20250046>
- Zhong, L., Ady, S. U., & Indrasari, M. (2026). AI in strategic management and organizational agility of SMEs: Leadership, policy environment, and adaptive capability. *Future Technology*, 5(2), 1-12. <https://doi.org/10.55670/fpll.futech.5.2.1>

Reconstructing and Translating Indigenous Ecological Culture Under the Impact of Innovative Technologies

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Abstract

Rapid advances in innovative technologies - such as artificial intelligence (AI), unmanned vehicles, automated sensing systems, and genetic modification—are profoundly reshaping the conditions under which Indigenous traditional ecological knowledge (TEK) and socio-cultural practices are sustained. These transformations raise not only practical concerns but also ontological questions regarding cultural continuity and emerging forms of digital colonialism. This study examines how the introduction of innovative technologies restructures social order and food-related cultural practices within Indigenous communities, with particular attention to Austronesian groups in Pingtung and Taitung, Taiwan. Drawing on science and technology studies (STS), cultural anthropology, agricultural biotechnology, and information engineering, the study conceptualizes a culturally resilient socio-technical network (STN) as an analytical framework for understanding these transformations. This research project extends to four sub-projects to carry out concrete actions: hoping to promote national digital transformation while implementing the spirit of diversity, equity, and inclusion (DEI) and social reconciliation, ensuring a deep dialogue between technological development and social needs, so that innovative technologies become guardians rather than substitutes of indigenous cultures.

Keywords: Information Self-determination; Traditional Ecological Knowledge; Science and Technology Studies; Appropriate Technology

1. Introduction

1.1 Foreword

While artificial intelligence (AI), automated sensing technologies, and genetic engineering are seen as key to solving current environmental challenges and industrial upgrading, they are also structurally reshaping human societal needs. In pursuing technological foresight, ensuring a deep dialogue between technology and societal needs, and assessing the impact of innovative technologies on specific communities within a cross-sectoral framework, has become a core issue for global academia and policymakers.

This research focuses on the Pingtung and Taitung regions of Taiwan—a vital repository

for Austronesian cultures (Paiwan, Rukai, Puyuma, and Amis) and their TEK (Huntington, 2000). However, as the national digital transformation blueprint extends into traditional folk culture, it faces the powerful intervention of AI governance, digital imaging technology, and genetic modification technology (GMO). Indigenous communities are experiencing an "ontological" cultural upheaval (Daly et al., 2016; Ludwig & Macnaghten, 2020). The introduction of innovative technologies not only changes traditional farming methods but also impacts the traditional contracts between people, the land, deities, and the community, raising concerns about digital colonialism and data hegemony.

Indigenous communities are increasingly positioned at the intersection of technological incorporation and cultural vulnerability, where the benefits of digital innovation coexist with risks of epistemic marginalization. If technological development lacks consideration for "cultural security" and "digital self-determination," it may exacerbate power inequality and erode the authority of traditional knowledge (Rouvroy & Pouillet, 2009). Therefore, this study aims to analyze the power shift mechanisms following the introduction of innovative technologies through interdisciplinary research, and to scientifically verify the repurchasing and translation of traditional Indigenous cultural wisdom. It is hoped that by constructing a culturally resilient Socio-Technical Network (STN), it can not only provide a legal foundation for protecting the rights of Taiwan's Indigenous peoples in the digital age, but also provide a localized practical path for the harmonious coexistence of technology and humanistic values when the nation promotes technological transformation (Zhao et al., 2025).

1.2 Research Objective

This study aims to analyze the ontological impact of innovative technologies (such as artificial intelligence (AI), digital transformation, and infrastructure modification) on indigenous societies and food cultures. It seeks to develop culturally appropriate technologies by constructing a "digital data sovereignty" governance framework, translating and preserving traditional ecological knowledge (TEK) (Huntington, 2000). Simultaneously, it combines scientific verification to strengthen the traditional cultural sovereignty of indigenous peoples, ultimately establishing an assessment model for the symbiotic relationship between innovative technologies and cultural resilience. This will provide forward-looking policy recommendations for safeguarding rights and interests during national digital transformation and for cross-ethnic social reconciliation. Therefore, the research objectives of this project are as follows:

- **Analyzing Power Reconfiguration:**

This study aims to explore the "translation process" of modern dietary habits, smart agriculture, and AIoT governance tools into traditional indigenous tribes. It seeks to analyze how innovative technologies can evolve beyond being merely neutral tools into "social technology networks" (STNs) that co-evolve with social order. Simultaneously, it investigates how to integrate the redistribution of knowledge discourse within tribes when digital and artificial intelligence technologies impact the cultural transmission experiences of tribal elders, preventing technology from becoming an "authority" that supersedes the elders (Sony & Naik, 2020).

- **Constructing Data Sovereignty Defenses:**

In response to the current situation of large-scale collection of Indigenous data into AI training databases, this study aims to prevent "digital sovereignty theft" and assess how to define "digital self-determination" (Rouvroy & Pouillet, 2009). It seeks to implement this

approach under Taiwanese law, ensuring that data collection is in the collective interest, under control, responsible, and ethical. Through the establishment of an autonomous data governance mechanism, it seeks to correct stereotypes and cultural misrepresentations of Indigenous peoples by AI-generated systems .

- Defining "Appropriate Technology" (AT):

This study attempts to define "indigenous-appropriate technology," ensuring that technology serves as a guardian rather than a substitute for culture. It involves developing digital tools that preserve tribal culture, such as transforming image monitoring technology from simple image storage into a tool for patrolling tribal territories and restoring ancient road routes. This will be achieved through the introduction of YOLOv8 Image Recognition and Participatory GIS (PGIS) empowers tribal youth with digital cultural and creative energy to protect traditional areas (Brown & Fagerholm, 2015) .

- Reconstructing Food Sovereignty:

Through verification by natural sciences, authoritative evidence is provided to support traditional folk plants and ecological wisdom. Using pharmaceutical quality testing and food nutrition analysis techniques, the medicinal properties and nutritional value of traditional indigenous folk plants are analyzed. Scientific data is used to refute the prejudice of "backward diet" during the digital colonial period; to prove the genetic advantages of traditional folk plants, enhance the market premium of tribal cultural brands, and rebuild the autonomy of tribal culture (Eisenberg et al., 2011) .

- Advancing DEI and Social Reconciliation:

This study not only pursues academic output but also emphasizes quantitative assessment and legal impact. It innovates theoretical models to dynamically evaluate the impact of technology introduction on cultural resilience, implementing the principles of Diversity, Equity, and Inclusion (DEI): ensuring the research process meets DEI requirements, and translating the results into environmental education resources that promote social reconciliation (Sbalay) (Lin, 2025) . Finally, it offers suggestions on an "AI Basic Law" and a "Genetic Resource Sharing (ABS)" mechanism to ensure the legal status of indigenous traditional folk knowledge in the digital age.

1.3 Research Background

In the context of a highly intertwined globalization and digital capitalism, technological innovation is reshaping the governance logic of society, the economy, and the environment at an unprecedented pace. This research project is based on the interdisciplinary intersection of innovative technology, science and technology studies (STS), and indigenous cultural studies, focusing its spatial field on Pingtung and Taitung regions of Taiwan. (Sismondo, 2018) . This region is not only a core distribution area for the Austronesian peoples of Taiwan (including the Paiwan, Rukai, Puyuma, and Amis), but also a key carrier of the genetic diversity and traditional ecological knowledge (TEK) of indigenous traditional plants such as millet and quinoa . However, when this land is included in the national digital transformation blueprint, facing the strong intervention of the Internet of Things (AIoT), digital image recognition technology, and genetically modified (GMO) food technology , indigenous tribes are facing an ontological cultural upheaval. The intervention of technology is not a neutral transfer of tools, but rather a reshuffling of social structures . From the perspective of STS, technology is never an object detached from social context, but rather a "socio-technical network" (Russ-Smith & Randell-Moon, 2025).

● The Myth of Neutrality:

In mainstream discourse, smart agriculture and digital transformation are often seen as the only solution to alleviate the aging of tribal labor and improve productivity. The smart greenhouses and monitoring systems promoted by the Ministry of Economic Affairs in Majia Township and Wutai Township, Pingtung County, have indeed significantly increased the economic value of specific crops and reduced labor burden by approximately 30% to 40%. However, under this logic of maximizing efficiency, the sacredness, human-land interaction, and tribal identity originally inherent in agricultural labor are being "black-boxed" by technology (Jasanoff, 2005). When sensors buried in the soil replace the sensory experience of tribal elders in "observing wind direction and phenology," the originally fluid traditional knowledge is transformed into cold, hard digital codes. This "epistemological gap" leads to outsiders who control the technology or young people with higher digital literacy rapidly surpassing traditional elders in the discourse of knowledge within the tribe. This phenomenon resonates strongly with Sheila Jasanoff's framework of "co-production": the process of producing scientific knowledge essentially reconstructs the moral order and legal authority of society simultaneously. (Jasanoff, 2004). If the cultural context of the technology introduction process is ignored, the so-called "technology empowerment" may very well turn into another form of "technological authoritarianism," thereby undermining the foundation of tribal self-governance.

● Digital Colonialism:

The development of AI technology is heavily reliant on massive amounts of data. Taiwan is actively building the "Taiwan AI Training Corpus" and collaborating with the Council of Indigenous Peoples, the Ministry of Education, and other organizations to collect high-quality traditional tribal language data. (Taiwan AI Training Corpus, 2026). However, from the perspective of Indigenous Data Sovereignty (IDSov), this data, involving language, ecological location, and ritual images, should not be considered freely accessible "public property" (Lovett et al., 2019). Historically, colonialism used the fabricated legal principle of "terra nullius" to plunder physical land; in the digital age, big data collection is a form of "digital land grab" (He) under the guise of "open data" or "technological innovation." Indigenous Data Sovereignty (IDSov) emphasizes that data is not only a technological resource but also the power foundation connecting historical memory and cultural continuity. If AI models, without informed consent and without implementing "benefit sharing," arbitrarily incorporate Indigenous intellectual property codes into black-box algorithms, it will lead to the problem of "digital colonialism." Empirical cases show that current AI image generation systems often produce cultural misinterpretations or reproduce stereotypes when presenting images of indigenous people due to biases in training data (such as mistakenly attributing Indonesian ethnic culture to Taiwanese indigenous people). This not only harms the dignity of the ethnic group, but also represents another form of elimination of subjectivity in the digital space. (Du, 2025).

● Food Sovereignty:

Innovative technologies on food culture extends beyond production, profoundly affecting consumption. The global flow of highly processed convenience foods and genetically modified crops threatens to undermine the traditional, highly diverse dietary systems of indigenous peoples (including gathering, hunting, and intercropping). Statistics indicate that this lack of dietary diversity has directly led to a significant increase in chronic disease prevalence among Taiwan's indigenous elderly, creating serious health inequalities. (Lizarralde et al., 2025). Food, in the indigenous worldview, is a "living cultural vessel." Take millet as an example: its growth

cycle is closely linked to all agricultural rituals (such as harvest festivals), and millet wine serves as an ontological medium for communicating with ancestral spirits. When smart agriculture promotes variety standardization for increased yields, or genetically modified millet dominates the market with strong competitiveness, millet's original sacred status will be replaced by a mere "calorie commodity." This is not only a loss of biodiversity but also a complete loss of "food sovereignty."

1.4 Research Question Definition

Based on the aforementioned complex socio-technical phenomena, this study proposes four core questions, aiming to analyze the dynamic balance between technology, ecology, and culture from an interdisciplinary perspective.

- **Restructuring the Power Map under Technological Intervention: How to Gain the Discourse Power in Technological Governance?**

This study, referencing research from Canadian scholars, examines how innovative technologies (such as sensors and artificial intelligence) and AI governance tools, once introduced into tribal communities, impact traditional social hierarchies and decision-making mechanisms. It explores how tribal deliberation democracy is mediated by digital technology when technological barriers exclude the participation of some elders. This involves the "translation process" in the sociology of technology—how technology combines heterogeneous actors (elders, youth, smart sensing technologies, educators, and government officials) into new digital networks. (Lizarralde et al., 2025).

- **The Defense Line of Data Sovereignty and AI Ethics: How to Prevent Digital Colonialism?**

When indigenous traditional knowledge is digitized into AI training data, how can we establish a system that aligns with the initiatives of GIDA (Global Indigenous Data Alliance)? What is the legal framework for the CARE principles (Collective Benefit, Authority to Control, Responsibility, Ethics)? This study aims to define the specific implementation path of "digital self-determination" under Taiwan's legal environment, with a particular focus on the authorization and modification mechanism of indigenous cultural data in the "Taiwan AI Training Corpus".

- **Localized Definition of "Appropriate Technology": How can Technology Serve Cultural Inheritance rather than Replace it?**

This study attempts to challenge the simplistic, linear thinking that "high technology equals progress." It defines "Appropriate Technology (AT)." Appropriate technology must possess "cultural safety," not only addressing aging issues in the community but also strengthening the connection between the people and the land. For example, can digital imaging technology be transformed into a "guardian" for tribal territorial patrols and digital trail restoration, rather than simply a digital record? And can these digital records not just be forgotten documents but also become important carriers of cultural heritage?

- **An Equal Dialogue Between Scientific Verification and Traditional Wisdom: How to Reconstruct Food Sovereignty?**

We examine the nutritional value and pharmacological activity of traditional indigenous crops (such as red quinoa, millet, and tree beans) and their preparation methods, and obtain authoritative endorsement through modern science (such as LC-MS/MS molecular fingerprint analysis) to counter the "backward diet" prejudice left over from the colonial period? Through such scientific translation, how can we substantially enhance the autonomy of tribal industries, reduce dependence on external genetically modified foods, and transform this evidence into

materials for tribal environmental education, further becoming an important cultural and educational asset for promoting tribal integration and protecting indigenous culture ?

1.5 Cross-disciplinary integrated research program framework

● System Matrix of the Overall Research Framework

The table below presents how the core disciplinary areas of this study correspond to the specific research objectives of this project through a research theory perspective:

Table 1
Interdisciplinary Framework of the Research Program

Core disciplines	Imported theoretical perspectives and analytical tools	The systematic integration objective of this plan
Science and Technology Studies (STS)	Co-production, Actor Network Theory (ANT), Displacement Theory	depicts the co-evolution of AIoT technology and tribal social order, revealing the social value inherent in the technology .
Cultural Anthropology	Ontological Turn , Traditional Ecological Knowledge (TEK)	To rescue the endangered TEK knowledge and preservation techniques, and to restore the status of "non-human actors" in tribal life.
Digital governance and legal norms	Indigenous Peoples' Data Sovereignty (IDSov), CARE, and FAIR Principles	Establish a data governance mechanism that conforms to the original democratic system, and formulate ethical norms for data collection by multinational corporations and countries.
Agricultural Science and Biotechnology	LC-MS/MS activity analysis and functional nutrient identification	Providing rigorous scientific endorsement for traditional crops highlights the modern value of TEK and enhances the resilience of indigenous cultures .
Information Engineering (AI/UAV)	YOLOv8 Object Detection, Participatory GIS (PGIS)	Develop indigenous-oriented technological tools to empower tribal youth with digital creativity and protect traditional territories.
Local Education and	Critical pedagogy, the spirit of reconciliation	Translate research data into teaching materials that foster cultural confidence,

Communication Policies	(Sbalay)	promote cross-ethnic communication, and implement transitional justice.
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● Theoretical Model Innovation: Social-Technological-Cultural Resilience Indicator (SCR_{idx})

To quantify the effectiveness of the program, the study, based on the theory of STS (Science, Technology, and Society), proposed an interdisciplinary theoretical integral formula to measure the dynamic changes in "cultural resilience" after the introduction of technology. This quantitative formula served as a concrete indicator for evaluating the achievement of the program's "milestones" in the subsequent three years of fieldwork and scientific analysis.

● Detailed Explanation of Sub-Projects within the Cross-Domain Integration Plan

This study comprises four interconnected sub-projects, covering the entire process from deep cultural documentation to high-level scientific verification.

Sub-project 1: In-depth interviews with tribal elders and documentation of traditional food culture preservation (anthropology and STS)

- In-depth participatory observation and qualitative research : Researchers will spend long-term time in Paiwan and Rukai tribes, recording not only plants and recipes, but also the rituals, taboos, climate observation techniques and tribal culture that accompany crop growth.
- Seed Saving Practices : Establishing a "tribal-level micro-smart seed bank." This involves collecting various native seed strains and recording their tribal names, family origins, usage methods, and specific ritual applications. Each seed is paired with a digital audio recording to ensure its ecological and cultural significance is not lost due to biodiversity loss.

Sub-project 2: Participatory Ecological Mapping Recording through Youth Collaboration and AI Image Recognition (Computer Science and Sociology)

- Localized Applications of AI Image Recognition : The latest YOLOv8 algorithm is introduced to train models for traditional crops and medicinal plants identified in Sub-Project 1. The research will combine "unmanned vehicles" and "Super Token Attention" (STA) to improve the detection accuracy of small, occluded plant targets in forests, enabling its application in automated ecological patrols (Chen et al., 2024).
- Participatory GIS (PGIS) and Digital Mapping : Empowering tribal youth to use unmanned vehicles to create 3D models of traditional areas. The maps are no longer just latitude and longitude coordinates, but rather "cultural landscape maps" that integrate tribal place names, ancient trail memories, and ecological monitoring data (Brown & Fagerholm, 2015; Radil & Anderson, 2019; Verplanke et al., 2016; Vieira da Silva et al., 2021).

Sub-project 3: Scientific validation and analysis of the nutritional value and pharmacological activity of traditional crops (Biotechnology and Nutritional Science)

- Advanced instrument identification (LC-MS/MS) : Liquid chromatography-tandem mass

spectrometry was used to analyze the unique bioactive metabolites in Pingtung red quinoa and native millet. Previous studies have generally agreed that ancient grains (such as red quinoa) should be defined primarily based on their bioactivity and chemical composition, typically containing a large number of health-promoting phytochemicals (Rocchetti et al., 2019; Taylor & Awika, 2017).

- Scientific endorsement of food sovereignty : By comparing the analysis results with commercially available genetically modified crops, the genetic advantages and functional value of native varieties in resisting extreme climates (drought, pests and diseases) are highlighted, thereby enhancing the market premium and health influence of tribal products.

Sub- project 4: Empowerment and Reconciliation in Environmental Education Planning and Inter-ethnic Communication (Education and Policy Governance)

- Interdisciplinary curriculum development : Translate the results of the above three sub-projects (oral history, digital maps, and scientific data) into environmental education curriculum materials that conform to the educational sovereignty of indigenous peoples, and promote the integration of ethnic history and ecological knowledge into the mainstream education system.
- Policy and ethics framework recommendations: ensure that any future AI research involving tribal data adheres to informed consent and benefit-sharing principles, thereby preventing the spread of digital colonization through legal and institutional means.

2. In-depth analysis and insights: Key variables in technology governance

2.1 Epistemological Turn: A Translation from "Substitution" to "Cooperation"

The failure of many current technology policies stems from "epistemological violence." Governments attempt to "replace" tribal sensory experiences with data metrics. This study emphasizes "hybrid governance," which involves "ontologically correcting" sensor data with elders' phenological observations. For example, AI-based rainfall prediction models should not be merely cold probability data; they can be combined with tribal priests' observations of celestial phenomena to form a more socially credible disaster prevention decision-making system.

2.2 Hidden Violence and "Nursing" in Infrastructure

Tribal interviews reveal that providing wearable health devices (such as smartwatches) to indigenous elders often constitutes "invisible surveillance." Data is uploaded to the cloud for access, but the elders have no control over their own physiological or environmental data. This "one-way transparency" is a typical example of colonial logic. The study points out that future technological infrastructure must be "equal," and data use should be centered on tribal "care," rather than solely on one-way administrative efficiency.

2.3 A Global South Perspective and the Digital Bandung Conference

The impact of indigenous technology on Taiwan is not an isolated incident. The international academic community is advocating for a "Digital Bandung Conference," calling on the Global South to build its own digital infrastructure to resist platform hegemony from Silicon Valley or China. This study positions the preservation of Taiwan's indigenous communities and its data sovereignty practices as part of a global network for indigenous

technology resistance, enhancing Taiwan's leading position on international issues through transnational cooperation (such as the IPETCA framework).

3. Implementing DEI requirements and conducting social benefit assessments

This study strictly adheres to the requirements of "Diversity, Equity and Inclusion" (DEI), incorporating it into core considerations of research design and team composition, including:

3.1 Diversity: Heterogeneous teams and stakeholder participation

The research team comprises experts from the natural sciences (biotechnology, information technology), humanities and social sciences (anthropology, sociology), and practitioners (community tribal development associations, smart farmers). A "tribal co-review mechanism" is in place at each stage of the research, inviting tribal elders and young people to participate in revising and providing feedback on the research plan, ensuring that the research questions closely reflect real local needs.

3.2 Equity: Power Conferment and Data Self-Determination

This study specifically analyzes the dominant role of indigenous women in traditional dietary culture (especially in planting and cooking) to avoid gender marginalization caused by the introduction of technology. In addition, the research establishes a data benefit-sharing mechanism to ensure that the scientific data generated by the sub-projects can be returned to the participating tribes free of charge, serving as scientific endorsement for their future development of community-based cultural and creative brands (such as functional red quinoa products).

3.3 Inclusion: Cross-cultural understanding and Sbalay

The study's outcomes will be presented through a multicultural approach, encompassing both indigenous languages and Chinese and English. The curriculum design will balance the educational needs of the community with communication with mainstream society. Through an "immersive digital electronic map exhibition," non-indigenous people will gain an understanding of the complexities of the symbiotic relationship between tribal land and technology through interactive experiences, dispelling stereotypes and achieving deeper social reconciliation.

4. Conclusions and Recommendations for Future Governance

The integrated research is not only an academic undertaking but also a social experiment on the democratization of technology and cultural revitalization. Through the critical perspective of STS, it reveals that innovative technologies can become tools of colonization while simultaneously highlighting the potential for technological transformation. The strategic recommendations for future governance frameworks include the following key dimensions:

- **Legal Institutionalization of Indigenous Data Sovereignty (IDSov):** It is recommended that the government incorporate a dedicated "Indigenous Data Chapter" during the legislative process of the "AI Basic Law" to formally establish the legal status and hierarchy of the CARE principles (Collective Benefit, Authority to Control, Responsibility, and Ethics).
- **Establishment of a Legal Mechanism for Access and Benefit-Sharing (ABS):** Drawing upon the framework of the Nagoya Protocol, the state should develop a context-specific ABS mechanism tailored to Taiwan's indigenous territories. This mechanism aims to

safeguard the bio-intellectual property rights of native crops and effectively curb "biopiracy".

- Promotion of "Appropriate Technology" Deliberative Committees: Future implementations of significant technological infrastructure within indigenous regions must undergo a "Cultural Impact Assessment" by the respective tribal councils. This ensures that the introduction of technology aligns with the long-term well-being and socio-ecological logic of the community.

Ultimately, this study aims to provide a model of cross-domain collaboration that is people-centered and respects diverse cultural entities within the social transformation of the AI era. By fostering this synergy, the glimmer of technology may illuminate traditional roots rather than scorching the soul of culture.

References

- Brown, G., & Fagerholm, N. (2015). Empirical PPGIS/PGIS mapping of ecosystem services: A review and evaluation. *Ecosystem Services*, 13, 119-133. <https://doi.org/10.1016/j.ecoser.2014.10.007>
- Chen, P., Chen, A., & Wang, C. (2024). STAFuse: A feature decomposition network with super token attention for multi-modality image fusion. In D.-S. Huang, Z. Si, & W. Chen (Eds.), *Advanced intelligent computing technology and applications: ICIC 2024* (Vol. 14880). Springer. https://doi.org/10.1007/978-981-97-5678-0_28
- Daly, L., French, K., Miller, T. L., & Nic Eoin, L. (2016). Integrating ontology into ethnobotanical research. *Journal of Ethnobiology*, 36(1), 1-9. <https://doi.org/10.2993/0278-0771-36.1.1>
- Du, Y. (2025). *From the United Nations to Taiwan: How can indigenous peoples reclaim the right to speak on AI data sovereignty?*. https://futurecity.cw.com.tw/article/3793?rec=i2i&from_id=3524&from_index=1
- Eisenberg, D. M., Harris, E. S. J., Littlefield, B. A., Cao, S., Craycroft, J. A., Scholten, R., Bayliss, P., Fu, Y., Wang, W., Qiao, Y., Zhao, Z., Chen, H., Liu, Y., Kaptchuk, T., Hahn, W. C., Wang, X., Roberts, T., Shamu, C. E., & Clardy, J. (2011). Developing a library of authenticated Traditional Chinese Medicinal (TCM) plants for systematic biological evaluation- Rationale, methods and preliminary results from a Sino-American collaboration. *Fitoterapia*, 82(1), 17-33. <https://doi.org/10.1016/j.fitote.2010.11.017>
- Huntington, H. P. (2000). Using traditional ecological knowledge in science: Methods and applications. *Ecological Applications*, 10(5), 1270-1274. [https://doi.org/10.1890/1051-0761\(2000\)010\[1270:UTEKIS\]2.0.CO;2](https://doi.org/10.1890/1051-0761(2000)010[1270:UTEKIS]2.0.CO;2)
- Jasanoff, S. (2004). *States of knowledge*. Taylor & Francis Abingdon, UK.
- Jasanoff, S. (2005). *Designs on nature: Science and democracy in Europe and the United States*. Princeton University press.
- Lin, H. (2025). *Indigenous language teaching and learning: Practices in the Cou Saviki tribal classroom in Taiwan* (Publication No. 31763553) [Doctoral dissertation, University of Washington]. ProQuest Dissertations & Theses A&I. <https://www.proquest.com/dissertations-theses/indigenous-language-teaching-learning-practices/docview/3193520509/se-2>
- Lizarralde, G., Latorre, S., Clavijo, N., Herazo, B., Pérez, M., Gould, K., Paredes, M., Monsalve, E., Ordoñez, N., & Burdiles, R. (2025). The spaces in between: An actor network analysis of alternative food systems in Latin America and the Caribbean. *Frontiers in Sustainable Food Systems*, 9, 1460343.

- <https://doi.org/10.3389/fsufs.2025.1460343>.
- Lovett, R., Lee, V., Kukutai, T., Cormack, D., Rainie, S. C., & Walker, J. (2019). Good data practices for Indigenous data sovereignty and governance. *Good data*, 1, 26-36.
- Ludwig, D., & Macnaghten, P. (2020). Traditional ecological knowledge in innovation governance: a framework for responsible and just innovation. *Journal of Responsible Innovation*, 7(1), 26-44. <https://doi.org/10.1080/23299460.2019.1676686>
- Radil, S. M., & Anderson, M. B. (2019). Rethinking PGIS: Participatory or (post)political GIS? *Progress in Human Geography*, 43(2), 195–213. <https://doi.org/10.1177/0309132517750774>
- Rocchetti, G., Lucini, L., Rodriguez, J. M. L., Barba, F. J., & Giuberti, G. (2019). Gluten-free flours from cereals, pseudocereals and legumes: Phenolic fingerprints and in vitro antioxidant properties. *Food Chemistry*, 271, 157-164. <https://doi.org/10.1016/j.foodchem.2018.07.176>
- Rouvroy, A., & Poullet, Y. (2009). *The right to informational self-determination and the value of self-development: Reassessing the importance of privacy for democracy*. Reinventing Data Protection?, Dordrecht.
- Russ-Smith, J., & Randell-Moon, H. (2025). AI and indigenous data sovereignty: Knowing, engaging, and learning in new data contexts. *Somatechnics*, 15(3), 287-295. <https://doi.org/10.3366/soma.2025.0467>
- Sismondo, S. (2018). Science and technology studies. In N. Castree, M. Hulme, & J. D. Proctor (Eds.), *Companion to environmental studies* (1st ed., pp. 356–359). Routledge. <https://doi.org/10.4324/9781315640051-72>
- Taiwan AI Training Corpus. (2026). <https://moda.gov.tw/en/digital-affairs/plural-innovation/operations/18874>
- Taylor, J., & Awika, J. (2017). *Gluten-free ancient grains: cereals, pseudocereals, and legumes: sustainable, Nutritious, and health-promoting foods for the 21st century*. Woodhead publishing.
- Verplanke, J., McCall, M. K., Uberhuaga, C., Rambaldi, G., & Haklay, M. (2016). A shared perspective for PGIS and VGI. *The Cartographic Journal*, 53(4), 308-317. <https://doi.org/10.1080/00087041.2016.1227552>
- Vieira da Silva, C., Ortigão, M., Willaert, T., Rosa, R., Nunes, L. C., & Cunha-e-Sá, M. A. (2021). Participatory geographic information systems (PGIS): Alternative approaches to identify potential conflicts and positional accuracy in marine and coastal ecosystem services. *Marine Policy*, 131, 104650. <https://doi.org/10.1016/j.marpol.2021.104650>
- Zhao, X., Wang, H., Sriwarnasinghe, S. M., Tang, J., Wang, S., Sugiyama, S., & Morikawa, S. (2025, January). Enhancing participatory development research in South Asia through LLM agents system: An empirically-grounded methodological initiative and agenda from field evidence in Sri Lanka. In R. Weerasinghe, I. Anuradha, & D. Sumanathilaka (Eds.), *Proceedings of the First Workshop on Natural Language Processing for Indo-Aryan and Dravidian Languages* (pp. 108–121). Association for Computational Linguistics. <https://aclanthology.org/2025.indonlp-1.13/>

Application of RWA in Taiwan's Agricultural Insurance: Based on Parametric Contracts and Decentralized Liquidity

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Abstract

Over the past several years, the accelerating impact of global climate change has left Taiwan's agriculture increasingly vulnerable to the risks of extreme weather phenomena including typhoons, torrential rains, and cold surges, leading to high economic losses. While conventional agricultural insurance is subsidized by the government, it consistently experiences three primary problems: high loss adjustment costs, delayed claim settlements, and low underwriting appetite in the reinsurance market. This study aims to explore the feasibility and application framework of deploying Real-World Asset (RWA) tokenization technology in Taiwan's agricultural insurance system. In this research, an "RWA Parametric Agricultural Insurance Model" is suggested that integrates Internet of Things (IoT) meteorological data, blockchain smart contracts, and Decentralized Finance (DeFi) liquidity pools. Thanks to a tokenization model involving agricultural insurance policies and claim capital pools, smart contracts can be used by these systems so as to achieve truly objective and automated "second-level settlements." Moreover, Taiwan's agricultural risks can be bundled into an RWA financial package to raise global Web3 market reinsurance capital, addressing the shortage of domestic capital momentum. Thus, this study concludes that the RWA model reduces adverse selection and moral hazard effectively, offering a practically valuable innovative path to the digital transformation of agricultural finance in Taiwan.

Keywords: Real-World Assets (RWA); Agricultural Insurance; Parametric Insurance; Smart Contracts; Climate Risk

1. Introduction

1.1 Research Background and Motivation

Taiwan has a particularly weather risky climate because its unique location causes many climatic impacts to agricultural production per annum. Taiwan's average annual agricultural economic losses due to natural disasters during the past ten years (2013-2023) stood at NT\$12 billion (Ministry of Agriculture, Executive Yuan, 2023). Even with the implementation of agricultural insurance through the government encouraging this approach and a risk diversification mechanism, which is coordinated by the

Agricultural Insurance Fund (2023), the conventional property insurance system is still characterized by high centralization and structural problems, such as excessively high disaster assessment costs, long processes for claims, and insufficient capacity in the domestic reinsurance market (Lin, 2020).

In recent years, the maturity of blockchain and decentralized finance (DeFi) technologies has provided a new paradigm shift for traditional financial services. While the decentralization of property insurance is rarely discussed, it has long been a focus of attention in academia and practice, and is being experimented with to varying degrees by various property insurance companies. Because property insurance involves numerous and complex insurance products, this study focuses on agricultural insurance. Through Real World Assets (RWA) technology, agricultural insurance policies and claims pools are transformed into on-chain digital assets. This not only overcomes the capital limitations of traditional centralized insurance institutions but also precisely connects to global liquidity (Voshmgir, 2020). This study aims to explore the application potential of RWA in Taiwan's agricultural insurance sector and demonstrate how decentralized architecture can solve the market failure problem of traditional agricultural insurance.

1.2 Research Objectives

- Analyze the institutional and technical dilemmas faced by Taiwan's current agricultural insurance.
- Construct a theoretical RWA parametric insurance model applicable to Taiwan's agricultural scenarios.
- Evaluate the feasibility and challenges of introducing RWA technology from regulatory, technical, and market perspectives.

2. Literature Review

2.1 Decentralization Opportunity in Traditional Agricultural Insurance

Traditional agricultural insurance has long faced a serious problem of information asymmetry, and we have been paying attention to this issue for some time. Mahul and Stutley (2010) noted that the agricultural systemic risk is extremely high and that traditional "indemnity-based" insurance is prone to adverse selection and moral hazard. Yang and Chen (2018) also highlight that fragmentation of farmland in Taiwan results in extremely high post-disaster survey costs which severely limit the willingness of commercial insurance companies to underwrite.

To address these problems, Gatteschi et al. (2018) suggest the possibility of reconstructing insurance mechanisms with blockchain and smart contracts, providing the technological foundation for decentralizing property insurance. Decentralized insurance protocols (like Nexus Mutual) leverage cryptographic methods and token economics to entrust risk-sharing mechanisms to community networks, greatly reducing the operating and agency costs imposed on centralized institutions.

2.2 Application of Parametric Insurance and Oracles

Parametric insurance relies on objective risk indicators (for example rainfall and wind speed) to trigger claims, removing moral hazard (Miranda & Farrin, 2012). But blockchain is a closed system and cannot access external climate data directly. Breidenbach et al. (2021), in their Chainlink 2.0 white paper, proposed a "Decentralized

Oracle Network (DON)," successfully solving this bottleneck. By securely uploading National Weather Service data to the blockchain through a multi-node consensus mechanism, parametric agricultural insurance can achieve fully automated claims processing (Raithatha & Priebe, 2020).

2.3 DeFi Insurance Protocols: Nexus Mutual and Arbol

The continued development of blockchain technology, coupled with the application of smart contracts in the insurance industry to drive automation, is transforming the operational model of insurance fund pools through cryptography and token economics.

2.3.1 Nexus Mutual: Decentralized Mutual Capital Pool Model

Nexus Mutual is one of the most representative decentralized insurance protocols in the DeFi space (Karp, H. 2019), focusing on "smart contract vulnerability" risks. Academic analysis of its mechanism includes:

- Risk Sharing and Tokenomics: The protocol adopts a "Mutual" concept. Investors deposit funds into the pool to receive NXM tokens and stake NXM to assess and underwrite specific smart contract risks.
- Claims Assessment Mechanism: Nexus Mutual is not fully automated; its claims require voting by community members (Claims Assessors).
- Limitations: Research indicates that the community voting mechanism faces governance disputes when dealing with "physical world damages" (such as agricultural losses) due to a lack of objective data. Therefore, its architecture is difficult to apply directly to RWA insurance for climate risk.

2.3.2 Arbol: Weather Parametric Protocol Based on Smart Contracts and Oracles

In comparison to Nexus Mutual, Arbol's architecture is more in line with the agricultural RWA application that we have studied in this study (McKinsey & Company. 2024). In the area of climate risk, Arbol is a decentralized parametric insurance platform.

- The addition of Oracles: Gatteschi et al. (2018), blockchains are unable to gain external knowledge, and thus can only use "Oracles". Arbol uses Decentralized Oracle Networks (DONs), such as Chainlink, to relay empirical weather information of national meteorological bureaus to the chain.
- Automated Execution and Capital Efficiency: According to academic analysis, Arbol writes weather parameters (e.g., rainfall) into smart contracts. When the data returned by the oracle exceeds the preset threshold, this contract automatically triggers a payout without manual review. This architecture fixes the contract execution trust issues of traditional parametric insurance quite neatly. Its administrative costs are also practically zero.

2.4 RWA as a Liquidity Bridge for Risk Transfer

A Boston Consulting Group (BCG, 2023) industry report predicts that the global RWA market will reach US\$16 trillion by 2030. Introducing the RWA concept into agricultural insurance means transforming traditional "insurance contracts" and "claims reserves" into on-chain tradable yield-bearing tokens. This model is a decentralized reshaping of the property insurance capital structure, enabling the transfer of local agricultural risks in Taiwan to the global Web3 capital market.

3. RWA Agricultural Insurance System Architecture and Core Technologies

Traditional agricultural insurance relies heavily on the credit endorsement of centralized institutions and manual underwriting (Yang, 2021). In contrast, the architecture proposed in this study combines the immutability of blockchain, the data consensus of decentralized oracles (DON), and tokenomics to achieve a trustless automated risk transfer mechanism (Voshmgir, 2020).

3.1 Infrastructure Layer: The Oracle Problem and Data Consensus Mechanism

Decentralized practice of property insurance, blockchain networks cannot proactively perceive physical changes in the real world (such as typhoon wind speed and rainfall). This technical bottleneck is known in academia as the "oracle problem" (Gatteschi et al., 2018). If a single data source is tampered with or becomes invalid, it will directly lead to incorrect claims processing by smart contracts.

To solve this problem, this research architecture incorporates the Decentralized Oracle Network (DON) proposed by Breidenbach et al. (2021).

- **Data Aggregation:** The approach does not depend on a single Application Programming Interface (API). In the case of Pingtung's wax apples wind disasters, oracles simultaneously fetch data from the Central Weather Administration (CWA) public API, private weather stations, and on-farm IoT wind sensors.
- **Off-Chain Reporting (OCR):** In order to minimize gas costs on-chain, several independent oracle nodes validate and integrate data off-chain via a Byzantine Fault Tolerant (BFT) algorithm.
- **Medianizer Algorithm:** The data submitted by each node is aggregated by means of a median (rather than an average) to ensure that outliers and malicious nodes are not included. If the aggregated wind speed exceeds the trigger threshold, the oracle runs a state update transaction to the insurance smart contract.

3.2 Protocol Layer: Tokenomics and Liquidity Pool Logic

The main application of RWA's is the tokenization of the "liquidity pool" of insurance, which is the critical distinguishing characteristic of the decentralized property and casualty insurance market versus the traditional reinsurance market. Raithatha and Priebe (2020) pointed out that through the blockchain microinsurance model, fragmented funds around the world can be effectively aggregated to support emerging markets or agricultural climate risks that lack liquidity.

3.2.1 Two-Tier Liquidity Pool Design

- **Senior Tranche:** Lower risk. In a catastrophe where the pool has to pay out, Senior Tranche funds are the last to be touched. In return, they receive a lower yield from premiums.
- **Junior Tranche (First-Loss Capital):** Higher risk. This tier takes on the initial wave of claim losses. If there is no calamity, most of the premium yield goes to Junior Tranche investors.

3.2.2 Pool Logic and Mathematical Model

P is the total premiums farmers will pay in USD Coin (USDC), and L is the total liquidity injected by investors. For 100% solvency (fully collateralized), the system must satisfy $L \geq M_{max}$, (M_{max} is the maximum potential payout).

When investors deposit USDC, the system mints and issues RWA yield certificates (e.g., iUSDC tokens). If no disaster occurs, the simplified Annual Percentage Yield (APY) model is:

$$APY = \frac{P \times (1 - F_{admin})}{L} \times 100\%$$

(Where F_{admin} is the protocol fee rate used for node operation).

3.3 Execution Layer: Smart Contract Pseudocode and Automated Claim Algorithm

Once oracles securely upload climate data to the blockchain, smart contracts take the place of regular property and casualty insurance company claims departments. Miranda and Farrin (2012) describe parametric insurance where claims conditions are completely driven by objective indicators.

3.3.1 Parametric Claim Algorithm

Take W as maximum gust wind speed (m/s) declared in the oracle. Let $W_{trigger}$ be the trigger threshold, W_{max} be the wind speed for a full payout, and S be the sum insured.

$$Payout = \begin{cases} 0 & \text{if } W < W_{trigger} \\ \frac{W - W_{trigger}}{W_{max} - W_{trigger}} \times S & \text{if } W_{trigger} \leq W \leq W_{max} \\ S & \text{if } W > W_{max} \end{cases}$$

Payout function is defined as:

3.3.2 Smart Contract Pseudocode (Simplified Solidity Logic)

Its main insurance contract logic is implemented in a Solidity-like language to illustrate the automated procedure from policy inception to oracle-activated claims processing.

3.4 System Security Mechanisms

This system architecture must incorporate strict cybersecurity measures to ensure the safety of agricultural funds. Its primary protections should include:

- Reentrancy Guard: The system strictly follows the "Checks-Effects-Interactions" pattern to prevent malicious nodes from repeatedly calling the withdrawal function.
- Circuit Breaker: If data shows irrational spikes (e.g., >150 m/s wind), the contract pauses for manual review by a multi-signature committee and weather experts.

4. Empirical Application Scenarios and Advantage Analysis

To validate the efficiency of the decentralized RWA system, the wax apple typhoon disaster parametric insurance in Pingtung, Taiwan is presented as an empirical case. Wax apples in Pingtung are a high-value crop that is very vulnerable to summer typhoons (Yang, 2021).

4.1 Scenario Construction: Pingtung Wax Apple Wind Insurance

Pingtung is Taiwan's primary wax apple region, but during typhoon season (July–Oct), it often causes fruit drop and branch breakage. Traditional insurance relies on

manual “on-site loss adjustment,” which is slow and prone to disputes over damage standards, the operational scenario:

1. Parameter Setting: "Max Gust Scale" is the trigger based on CWA Pingtung station data.
2. Asset Tokenization: The total coverage is minted as an RWA pool in USDC, open to global Web3 liquidity providers.
3. NFT Policies: Farmers buy insurance via local farmers' association nodes; the system generates an NFT policy representing the GPS coordinates and terms.

4.2 Mathematical Cost Models: Traditional vs. RWA

Let N be the number of farmers and p be the probability of a claim.

- Traditional Total Admin Cost (C_{trad}): The costs of the unified model mainly consist of "preliminary underwriting costs (C_{uw})" and "post-disaster on-site damage assessment and claims administrative costs (C_{claim}):

$$C_{trad} = N \cdot c_{uw} + (p \cdot N) \cdot c_{claim}$$

- RWA Total Admin Cost (C_{rwa}): The cost structure of the RWA model has shifted significantly to digital infrastructure costs, including "smart contract initial setup cost (C_{deploy})," "blockchain miner fees for minting a single Non-Fungible Token (NFT) policy (C_{mint})," and "miner fees for oracle data transmission and automated claims execution (C_{gas}).

$$C_{rwa} = C_{deploy} + N \cdot c_{mint} + (p \cdot N) \cdot c_{gas}$$

- Cost savings(ΔC): The total cost savings from importing RWA are:

$$\Delta C = C_{trad} - C_{rwa} = N \cdot (c_{uw} - c_{mint}) + p \cdot N \cdot (c_{claim} - c_{gas}) - C_{deploy}$$

4.3 Comparison of Simulated Data and Quantitative Benefits

In order to give a reliable scale of this relationship, it is based on appropriate simulation assumptions for estimating this relationship. If the promotion aims $N = 1,000$ wax apple farmers in Pingtung, for a given year probability of encountering a typhoon and meeting the claim criteria is $p = 0.3$ (i.e., 30% claim rate).

- Traditional cost parameter values: The estimated cost of manual underwriting and filing for a single claim is about NT\$500; the cost of on-site damage assessment, photography, and administrative review for a single claim is as high as NT\$3,000 (including personnel and transportation expenses).

- RWA cost parameter settings (based on a Layer 2 blockchain network such as Polygon): The fixed cost of smart contract construction is approximately NT\$15,000; the cost of NFT creation for a single policy is approximately NT\$15; the gas fee for automatic claim triggering and fund transfer for a single claim is approximately NT\$30.

Table 1

Comparison of Administrative Costs between Traditional and RWA Models (Unit: New Taiwan Dollars)

Cost items	Traditional agricultural insurance model	RWA Parametric Insurance Model	Comparison of differences
Fixed construction costs	0	15,000	RWA Initial setup requires costs
Total cost of initial underwriting	500,000 (500/household)	15,000	RWA Save 97%
Total cost of post-disaster claims	900,000(3,000/household × 300 households)	9,000	RWA Save 99%
Total administrative cost estimate	1,400,000	39,000	RWA Overall savings 97.2%
Claim settlement time	1 to 3 months	Within 5 minutes after triggering	Significantly improve capital turnover rate

The simulation above shows that, in a scenario with 1,000 households, the traditional model would incur administrative and disaster assessment costs of up to NT\$1.4 million; while the RWA model, through automated execution via procedural codes, can reduce the total cost to below NT\$40,000. This means that insurance companies can pass on the substantial savings in "operating costs" to farmers (by reducing premiums) or increase the coverage rate of claims.

4.4 Comprehensive Advantages of the RWA Model

Besides quantifiable cost reduction, the introduction of RWA into Taiwan's agricultural insurance offers the following qualitative advantages:

1. Decentralized Liquidity, Overcoming Domestic Reinsurance Bottlenecks: The limited size of Taiwan's insurance market makes transferring agricultural risks to the international reinsurance market extremely difficult. The RWA model tokenizes the climate risks of Taiwanese crops, directly connecting them to global DeFi pools, making international capital a safety net for Taiwanese agriculture.

2. Eliminating Moral Hazard and Information Asymmetry: Claims are entirely based on official meteorological data accessed via oracles, eliminating the possibility of farmers falsely reporting losses (moral hazard) or insurance companies deliberately underreporting claims.

3. Immediate Post-Disaster Financial Assistance: The months-long waiting period for traditional claims often causes farmers to miss the golden period for replanting. The "second-level claims" feature of smart contracts ensures that farmers receive funds immediately after a typhoon, significantly improving the climate resilience of agricultural operations.

5. Conclusion and Recommendations

5.1 Research Summary

This study finds that RWA parametric insurance presents a disruptive innovation for Taiwanese agricultural finance:

1. Cost Innovation: The Pingtung wax apple simulation based on RWA can reduce underwriting and claims processing costs by more than 97% and shorten the claims processing time from months to minutes.

2. Global Liquidity: With RWA yield certificates, Taiwan can bypass domestic market limitations and tap into the global Web3 DeFi capital by packaging risk as RWA yield certificates.
3. Real-world challenges: Government regulatory restrictions and the digital divide remain major obstacles to large-scale adoption in the short term.

5.2 Policy Recommendations

1. To the Financial Supervisory Commission (FSC):
 - Create an "Agricultural FinTech Sandbox": Relax the provisions of Article 136 of Taiwan's Insurance Act within the sandbox to allow smart contract-based experiments for specific crops.
 - Define RWA Token Attributes: Provide clear and differentiated guidelines for "yield tokens" and "policy NFTs" to avoid stifling innovation due to overly broad classifications of Security Token Offerings (STOs).
2. To the Ministry of Agriculture (MOA):
 - Improve the national "Agricultural Data Open Platform": Standardize and integrate IoT and weather station data into decentralized oracle (e.g., Chainlink) compatible APIs.
 - Mentor farmer groups to become "Web 2.5 nodes": Support farmer groups in establishing multi-signature wallets to manage on-chain transactions for farmers, maintaining local trust while leveraging blockchain efficiency.

5.3 Future Research

Future research could combine artificial intelligence and machine learning models to improve the accuracy of meteorological parameter triggering. Furthermore, exploring how to integrate RWA agricultural insurance with carbon credits or renewable energy finance (ReFi) to construct a sustainable token economy framework, enabling farmers to receive RWA premium discounts when adopting carbon-reducing farming practices, is also a promising direction.

References

- Agricultural Insurance Fund. (2023). *2022 Annual Report of the Agricultural Insurance Fund*. Agricultural Insurance Fund.
- Boston Consulting Group. (BCG). (2023). *Relevance of on-chain asset tokenization in 'crypto winter'*. BCG Global Report
- Breidenbach, L., Cachin, C., Chan, B., Coventry, A., Ellis, S., Juels, A., ... & Zhang, F. (2021). *Chainlink 2.0: Next steps in the evolution of decentralized oracle networks* (White paper). Chainlink Labs.
- Gatteschi, V., Lamberti, F., Demartini, C., Pranteda, C., & Santamaría, V. (2018). Blockchain and smart contracts for insurance: Is the technology mature enough? *Future Internet*, 10(2), 20. <https://doi.org/10.3390/fi10020020>
- Karp, H. (2019). *Nexus Mutual: A decentralized alternative to insurance*. Whitepaper. <https://nexusmutual.io/whitepaper.pdf>
- Lin, K. C. (2020). A study on agricultural disaster relief and agricultural insurance in Taiwan. *Agriculture Policy and Review*, (332), 15-22. (In Chinese)
- Mahul, O., & Stutley, C. J. (2010). *Government support to agricultural insurance: Challenges and options for developing countries*. World Bank Publications. <https://doi.org/10.1596/978-0-8213-8217-2>

- McKinsey & Company. (2024). *Scaling a niche start-up into a necessary one: Insights from Arbol*. <https://www.mckinsey.com/capabilities/tech-and-ai/our-insights/scaling-a-niche-start-up-into-a-necessary-one-insights-from-arbol>
- Ministry of Agriculture, Executive Yuan. (2023). *Agricultural Statistics Yearbook*. Ministry of Agriculture. (In Chinese)
- Miranda, M. J., & Farrin, K. (2012). Index insurance for developing countries. *Applied Economic Perspectives and Policy*, 34(3), 391-427. <https://doi.org/10.1093/aepp/pps031>
- Raithatha, R., & Priebe, J. (2020). *Agricultural insurance for smallholder farmers: Digital innovations for scale*. GSMA.
- Voshmgir, S. (2020). *Token Economy: How the Web3 reinvents the Internet* (2nd ed.). Token Kitchen.
- Yang, M. S., & Chen, J. C. (2018). Planning, promotion, and prospects of Taiwan's agricultural insurance system. *Taiwan Journal of Agricultural Economics*, 24(1), 1-35. (In Chinese)
- Yang, M.S. (2021). Development and challenges of agricultural insurance under climate change: a case study of weather parameter insurance. *Taiwan Agricultural Research*, 70(3), 189-202.