

Developing the Cultural Meaning Preservation Assessment (CMPA): A Multidimensional Methodology for Evaluating AI-Assisted Translation of Indigenous Cultural Knowledge Units

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ABSTRACT

Kemajuan kecerdasan buatan (AI) telah memperkuat kualitas terjemahan dengan memanfaatkan beberapa sistem terjemahan berbantuan AI yang menghasilkan terjemahan kata yang lebih cepat dan lebih akurat secara linguistik dibanding sebelumnya (Koehn, 2020; Toral & Way, 2018). Namun demikian, AI juga mengalami tantangan dalam mempertahankan makna budaya pada jarak; terutama terkait dengan kelas unit pengetahuan yang akan kita sebut di sini sebagai Indigenous Cultural Knowledge Units (ICKUs), yang sangat terkait dengan nilai identitas historis, sosial, dan budaya—jika ada dua subhimpunan yang dapat menantang perluasan kapasitas paralel kita. Studi Terjemahan telah mengembangkan beberapa kerangka kerja untuk Penilaian Kualitas Terjemahan (House 2015, TQA), MQM, DQF, BLEU, dan COMET) yang terutama berfokus pada kesetaraan semantis dan akurasi linguistik, tetapi sejauh ini belum ada alat yang menilai pelestarian makna budaya. Terdapat tiga tujuan dalam penelitian ini: (1) mengembangkan Cultural Meaning Preservation Assessment (CMPA); yaitu metode multidimensi untuk mengevaluasi sistem AI yang melestarikan makna budaya dari terjemahan ICKUs dari Kutai Adat Lawas. Desain penelitian: Penelitian ini menerapkan desain deskriptif kualitatif, yaitu pendekatan metodologis dalam ilmu kesehatan atau ilmu sosial. Korpus lengkap penelitian berisi 25 ICKU beserta Human Gold Standard Translation sebagai acuan, yang dikembangkan melalui teknik peminjaman dan deskripsi (Newmark, 1988). Terjemahan yang difasilitasi oleh Google Translate, DeepL, ChatGPT, Gemini, dan Claude dievaluasi berdasarkan enam dimensi spesifik CMPA: pelestarian leksikal, semantik, budaya, historis, dan pragmatik, serta pelestarian identitas pribumi. Hasil menunjukkan bahwa meskipun sebagian besar sistem AI bekerja memadai terkait kesetaraan leksikal dan semantik, mempertahankan makna identitas historis, pragmatik, dan budaya tetap menjadi kelemahan utama. CMPA memberikan kontribusi metodologis sebagai kerangka kerja holistik untuk mengevaluasi pemeliharaan makna budaya dalam terjemahan berbantuan AI.

Kata Kunci: *Penerjemahan Berbantuan Kecerdasan Buatan, Penilaian Pelestarian Makna Budaya (Cultural Meaning Preservation Assessment/CMPA), Unit Pengetahuan Budaya Adat (Indigenous Cultural Knowledge Units/ICKUs), Penilaian Kualitas Terjemahan, Pelestarian Makna Budaya, Kutai Adat Lawas.*

ABSTRACT

Recent advances in artificial intelligence (AI) have substantially improved translation quality through the development of AI-assisted translation systems capable of producing faster and linguistically more accurate lexical translations than previous approaches (Koehn, 2020; Toral & Way, 2018). Nevertheless, AI continues to face significant challenges in preserving cultural meaning, particularly when translating a category of knowledge referred to in this study as Indigenous Cultural Knowledge Units (ICKUs). These units embody historically, socially, and culturally embedded identities that are difficult to represent through conventional computational translation models. Although Translation Studies has developed

several well-established Translation Quality Assessment (TQA) frameworks—including House’s TQA model (2015), MQM, DQF, BLEU, and COMET—which primarily evaluate semantic equivalence and linguistic accuracy, no existing framework specifically assesses the preservation of cultural meaning. Accordingly, this study aims to develop the Cultural Meaning Preservation Assessment (CMPA), a multidimensional assessment methodology designed to evaluate the extent to which AI-assisted translation systems preserve the cultural meaning of ICKUs derived from Kutai Adat Lawas. This research adopts a qualitative descriptive design commonly employed in the social sciences. The research corpus consists of 25 ICKUs accompanied by Human Gold Standard Translations developed using Newmark’s (1988) borrowing and descriptive translation techniques. AI-generated translations produced by Google Translate, DeepL, ChatGPT, Gemini, and Claude were evaluated using six CMPA dimensions: lexical preservation, semantic preservation, cultural preservation, historical preservation, pragmatic preservation, and Indigenous identity preservation. The findings indicate that while most AI translation systems perform satisfactorily in achieving lexical equivalence and semantic accuracy, they continue to exhibit substantial limitations in preserving historical identity, pragmatic meaning, and culturally embedded knowledge. The proposed CMPA offers a methodological contribution by providing a comprehensive and holistic framework for evaluating cultural meaning preservation in AI-assisted translation.

Keywords: *Artificial Intelligence-Assisted Translation; Cultural Meaning Preservation Assessment (CMPA); Indigenous Cultural Knowledge Units (ICKUs); Translation Quality Assessment; Cultural Meaning Preservation; Kutai Adat Lawas.*

A. INTRODUCTION

The rapid development of artificial intelligence technology is reshaping the field of translation, upgrading the industry across three core dimensions: linguistic accuracy, contextual comprehension, and multilingual adaptability. Relying on technical breakthroughs in neural machine translation and large language models, five mainstream AI translation systems including Google Translate have gained wide application (Koehn, 2020; Toral & Way, 2018; OpenAI, 2023). However, existing translation quality assessment only takes linguistic accuracy as its evaluation standard, and faces obvious limitations when handling scenarios that embed embedded cultural knowledge.

Drawing on existing research by Bassnett (2021), Baker (2018), and House (2015), the translation studies community generally views translation as an intermediary process of cross-cultural communication, rather than a mere conversion of linguistic forms. A successful translation must cover five core dimensions: lexical semantics, cultural values, historical context, pragmatic function, and social identity. The translation of Indigenous cultural knowledge poses particularly prominent challenges. This study focuses on units of Indigenous cultural knowledge originating from ancient Kutai law, which carry four core types of connotations: customary law, rituals, social systems, and indigenous philosophy.

Current mainstream AI-assisted translation systems deliver stable, strong translation performance at the lexical and semantic levels, but they often encounter barriers when processing Indigenous culture-bound terms. Recent studies by scholars including Castilho, Kenny, and Liu confirm that relying exclusively on lexical equivalence cannot convey deep cultural context, easily leading to three typical types

of errors. The produced translations are linguistically accurate, yet they lose the original cultural connotations of the source text.

Current mainstream translation quality assessment frameworks, such as House (2015), MQM, BLEU and others, mostly focus only on linguistic quality, fluency, and semantic equivalence. While these frameworks have advanced the development of the field, they have exposed a methodological gap: the lack of cultural retention assessment, which emerges when AI-assisted translation processes units of Indigenous cultural knowledge.

To fill the research gap in the field of AI-assisted translation, this study proposes the Cultural Meaning Preservation Assessment (CMPA) framework, which covers six core dimensions. This framework breaks through the limitation of traditional tools that only focus on linguistic performance, expanding the scope of assessment to the comprehensive evaluation of culturally embedded meanings.

This study intends to develop and apply the Cultural Meaning Preservation Assessment tool, CMPA, to evaluate the level of cultural meaning retention in AI-assisted translated drafts of Indigenous cultural knowledge units tied to Kutai traditional customary law (Kutai Adat Lawas). The study centers on three core research questions, including the development of the CMPA and the performance comparison of mainstream AI translation systems. It will produce three clear categories of expected academic and application-focused contributions across the theoretical, methodological, and practical levels.

B. LITERATURE REVIEW

Addressing the research gap outlined in the preceding sections of this work, this review sets out to evaluate how well the cultural significance of Indigenous Cultural Knowledge Units (ICKUs) is retained in AI-assisted translation. Drawing on existing research by scholars including Baker (2018), House (2015), and Koehn (2020), this review integrates theories from six domains that cover Translation Quality Assessment (TQA), to lay the conceptual foundation for the original CMPA.

2.1 Artificial Intelligence-Assisted Translation

Mapped along its development timeline, artificial intelligence-assisted translation (AIAT) has undergone multiple generations of technological upgrades, achieving continuous breakthroughs in core translation accuracy and cross-language adaptability. Mainstream commercial systems such as Google Translate and DeepL have been successively launched and are currently widely applied in various cross-language scenarios (Jones et al., 2023).

Although the lexical and semantic accuracy of current AI translation has improved significantly, studies by Castillo (2023) and Kenny (2022) note that it still fails to properly retain embedded cultural connotations, creating an urgent need to build a new translation evaluation framework that covers the requirements for cultural retention.

2.2 Translation as Intercultural Communication and Cultural Mediation

The update of the core paradigm in the field of contemporary translation studies has overturned the traditional understanding that treats translation as nothing more than a simple conversion of linguistic forms. Bassnett (2021) and Baker (2018) define this practice as an intermediary process of cross-cultural negotiation, while House (2015) and Nord (2018) argue that translators must take into account, in sequence, four core criteria: semantic equivalence, cultural value, historical context, and pragmatic function.

The perspective of this study aligns with the cultural context of Indigenous peoples, whose languages carry collective memory, customs, and identity—requiring that translation balances both linguistic accuracy and the preservation of cultural meaning.

2.3 Translation Techniques and Translation Strategies

In the field of translation, techniques and strategies are often confused. When carrying out translation work, appropriate applications of the two must be selected to preserve the meaning of the source text and guarantee communicative effectiveness. Techniques are micro-level operational practices, while strategies function as macro-level guiding frameworks. This classification draws on the classic academic research findings of Molina and other scholars.

The academic community generally recognizes that the "borrowing combined with interpretation" translation method for culture-bound linguistic expressions is effective, as it retains indigenous terms from the source language while supplementing them with contextual explanations. On this basis, the present study will independently develop the Cultural Meaning Preservation Assessment (CMPA) tool, using this translation strategy as its foundation.

2.4 Indigenous Cultural Knowledge Units (ICKUs)

This paper draws on official documents from the United Nations (2007) and UNESCO (2021) to define the core meaning of Indigenous cultural knowledge. It then cites the 2007 research by field scholar Nakata, pointing out that because this knowledge is deeply tied to cultural identity and collective memory, a large number of its cultural expressions have no direct equivalent formulations across languages.

This study introduces the concept of ICKUs, which carry the core culture of Indigenous peoples. Drawing on the definitions put forward by Bassnett (2021) and Baker (2018), the study selects ICKUs from Kutai Adat Lawas to construct a corpus, which is used to evaluate the effectiveness of cultural meaning retention in AI-assisted translation.

2.5 Cultural Meaning Preservation

Translation studies should not center solely on linguistic equivalence. As defined by House (2015) and Bassnett (2021), the preservation of cultural meaning must cover four categories of connotations. Therefore, a qualified translation must retain both the semantic meaning of the source text and the cultural knowledge it carries.

This study conceptualizes the retention of cultural meaning as a multi-dimensional construct, which is broken down into six specific sub-dimensions. This framework serves as the core support for the independently developed CMPA assessment tool.

2.6 Translation Quality Assessment

Translation Quality Assessment (TQA) provides a systematic pathway for domain research. The five major mainstream frameworks proposed by the academic community, including that developed by House (2015), have advanced the development of this field through three core dimensions.

Previous studies have laid the foundation for the TQA framework, but these frameworks only focus on linguistic computational performance. Their shortcomings become prominent when they are used to evaluate AI translations of indigenous cultural knowledge units, so there is an urgent need to construct a culture-oriented evaluation framework.

2.7 Research Gap and Theoretical Synthesis

Based on a review of existing literature, substantive progress has been achieved in the fields of AI-aided translation, translation studies, and translation quality assessment. Most existing studies only focus on linguistic accuracy and semantic equivalence, and very few evaluate the retention of four core dimensions related to Indigenous culture.

To fill the existing research gap in cultural significance assessment for AI-assisted translation, this study proposes the Cultural Meaning Preservation Assessment (CMPA) framework. This framework integrates theories from five major domains, laying the conceptual foundation for assessment work and providing guidance for subsequent research method frameworks.

C. METHOD

This study draws on the theoretical framework proposed in its literature review to develop the Cultural Meaning Preservation Assessment (CMPA), a tool for evaluating cultural meaning retention. The tool is implemented across six stages, including research design and corpus selection. To guarantee the CMPA's transparency, consistency, and replicability, the study cites authoritative methodological literature by Creswell & Creswell (2023) and Tracy (2020). The CMPA is used to assess the AI-aided translation quality of Indigenous Cultural Knowledge Units (ICKUs).

3.1 Research Design

This study adopts a descriptive qualitative design under the methodological research approach, and draws on authoritative methodological literature to substantiate the rationality of this design. The study aims to interpret the implications of cultural retention in AI-generated translations, and construct a CMPA evaluation framework for AI-assisted translation. Distinct from traditional TQA models, this framework sets six complementary cultural evaluation dimensions.

3.2 Research Corpus

The Indigenous cultural knowledge corpus constructed in this study clarifies its sample sources and sampling methods. Its corpus materials cover six core cultural domains, and three strict inclusion criteria have been established to guarantee corpus quality. This corpus will serve as a standardized dataset, used to evaluate the ability of different AI-assisted translation systems to preserve the core cultural meaning embedded in texts, laying a core foundation for subsequent translation evaluation research.

Table 1. Research Corpus of Indigenous Cultural Knowledge Units (ICKUs)

No.	Indigenous Cultural Knowledge Unit (ICKU)	Cultural Domain	Source
1	Beseprah	Traditional Ritual	Indonesia Kaya
2	Upacara Erau	Traditional Ritual	Indonesia Kaya
3	Belian Namang	Traditional Ritual	BRWA
4	Besawai	Traditional Ritual	BRWA
5	Pelas Uling	Traditional Ritual	BRWA
6	Sorong Tande	Marriage Tradition	BRWA
7	Betuhing	Marriage Tradition	BRWA
8	Puan	Traditional Leadership and Social Structure	BRWA
9	Jogo Wono	Traditional Leadership and Social Structure	BRWA
10	Hulun	Traditional Leadership and Social Structure	BRWA
11	Supangan Raja	Traditional Leadership and Social Structure	BRWA
12	Bicara	Customary Law	BRWA
13	Gawai	Customary Law	BRWA
14	Krama Adat	Customary Law	BRWA
15	Himbe	Indigenous Land Classification	BRWA
16	Rapak	Indigenous Land Classification	BRWA
17	Humma	Indigenous Land Classification	BRWA
18	Rundung	Indigenous Land Classification	BRWA
19	Lemboan	Indigenous Land Classification	BRWA
20	Namang	Spiritual Beliefs	BRWA
21	Roh Penjaga	Spiritual Beliefs	BRWA
22	Gence Ruan	Culinary Heritage	Indonesia Kaya
23	Seperah	Material Culture	Indonesia Kaya
24	Sumping Layang	Historical–Cultural Identity	BRWA
25	Kutai Adat Lawas	Historical–Cultural Identity	BRWA

Relying on the core corpus of this study presented in Table 1, which contains 25 Indigenous Cultural Knowledge Units (ICKUs) covering six domains of the Kutai ethnic group's traditional ancient laws (Kutai Adat Lawas), this corpus can be adapted to the CMPA framework proposed in this paper to assess the retention level of cultural significance. The research design of this study cites Patton (2015); Creswell & Creswell (2023).

3.3 Development of Human Gold Standard Translation

The human gold-standard translation HGST developed in this study is used as the benchmark for evaluating AI-assisted translation. It translates 25 key units of Indonesian culture from Indonesian into English, following the principle that cultural meaning takes precedence over literal equivalence. This principle is supported by two authoritative academic works in the field of translation studies.

This study integrates the classic translation strategies of Newmark (1988) and Molina and Hurtado Albir (2002) to develop HGST, which adopts loan translation to retain local terms, descriptive translation to supplement context, and works with the CMPA framework to evaluate mainstream machine translation models.

3.4 Development of the Cultural Meaning Preservation Assessment (CMPA)

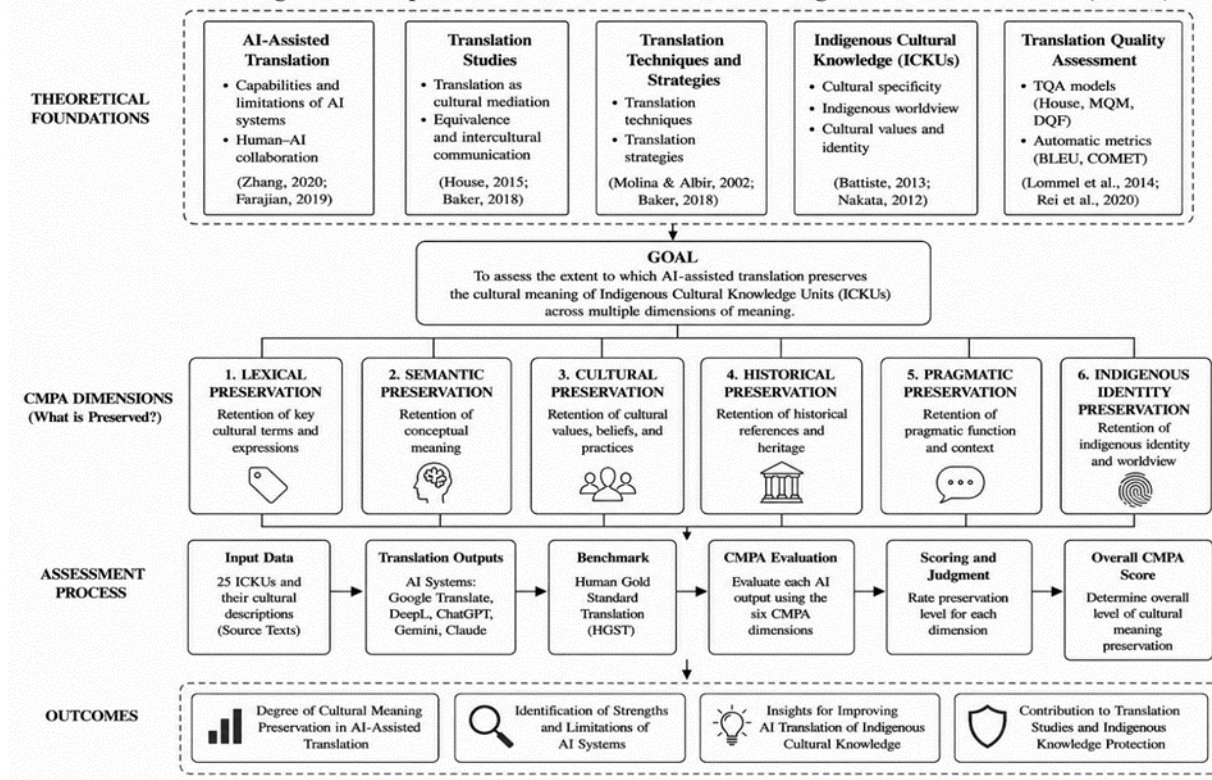
This study independently developed the Cultural Meaning Preservation Assessment (CMPA) framework, which is used to evaluate the retention of cultural meaning in AI-assisted translation. Unlike existing TQA models that only focus on language quality assessment, this framework integrates six dimensions across four major domains, and its development is supported by the academic literature of House (2015) and Rei et al. (2020).

The CMPA assessment framework developed in this paper is implemented in four sequential stages, which are completed in the following order: construct identification, dimension integration, standard transformation, and application testing. This framework possesses both a solid theoretical foundation and practical applicability.

3.4.1 Conceptual Framework

This study proposes the CMPA translation quality assessment framework, whose core premise is that translation quality must simultaneously balance linguistic accuracy and the retention of cultural meaning. The latter is broken down into six dimensions, including lexical, semantic, and cultural dimensions, which are used to evaluate the AI-aided translation of local cultural knowledge units (Indigenous Cultural Knowledge Units). Three prior studies, including that of Bassnett (2021), are cited to support the rationality of the framework's constructs. Figure 1 illustrates the internal connections within the framework, laying a conceptual foundation for subsequent analyses.

Figure 1. Conceptual Framework of the Cultural Meaning Preservation Assessment (CMPA)



As shown in Figure 1, the Cultural Meaning Preservation Assessment (CMPA) framework proposed in this paper integrates six interdisciplinary theories including AI-aided translation and translation studies, and provides a conceptual foundation for the assessment of cultural meaning preservation in AI-generated translations. The framework's practical operational components will be elaborated in subsequent sections, and the construction of the framework draws on prior research by House (2015) and Baker (2018).

3.4.2 Analytical Components

The independently constructed assessment tool CMPA proposed in this paper is operationalized into six analytical components, which are used to evaluate the cultural retention of Indigenous cultural knowledge in AI-assisted translation scenarios. Two classic methodological publications are cited to support the rationality of this underlying logic.

The cultural meaning preservation assessment framework constructed in this study includes six independent evaluation dimensions, such as the lexical and semantic dimensions. This framework outperforms the traditional Translation Quality Assessment, and detailed explanations of each dimension are provided in Table 2.

Table 2: Analytical Components of the Cultural Meaning Preservation Assessment (CMPA)

No.	Dimension	Operational Definition	Evaluation Focus	Theoretical Foundation
1.	Lexical Preservation	Preservation of the original indigenous lexical item or culturally significant terminology.	Whether the original cultural term is retained or appropriately represented.	Newmark (1988); Molina & Hurtado Albir (2002)
2.	Semantic Preservation	Preservation of the conceptual meaning expressed by the source text.	Accuracy of conceptual equivalence between source and target texts.	Baker (2018); House (2015)
3.	Cultural Preservation	Preservation of cultural values, beliefs, traditions, and practices embedded in the expression.	Retention of culturally specific knowledge.	Bassnett (2021); Hall (1997)
4.	Historical Preservation	Preservation of historical references, customary institutions, and collective memory.	Maintenance of historical context and indigenous heritage.	UNESCO (2021); Nakata (2007)
5.	Pragmatic Preservation	Preservation of communicative intention, contextual meaning, and social function.	Appropriateness of meaning within its cultural context.	House (2015); Baker (2018)
6.	Indigenous Identity Preservation	Preservation of indigenous identity, worldview, and epistemological values represented by the source expression.	Representation of indigenous identity in translation.	Battiste (2013); United Nations (2007)

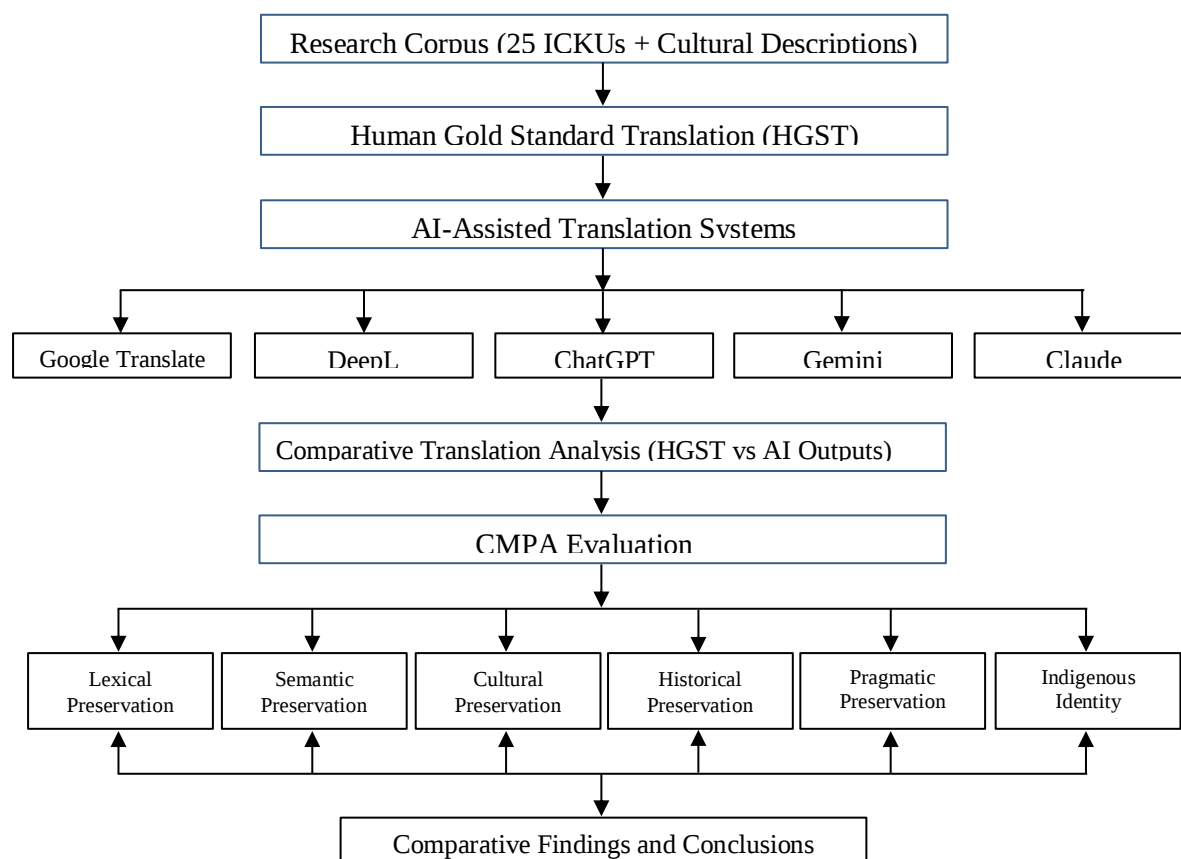
The CMPA framework proposed in this study draws on Table 2 presented in this paper to transform the preservation of cultural meanings into six complementary analytical dimensions, which are used to evaluate AI-assisted translation of Indigenous cultural knowledge units. The framework integrates five perspectives including linguistics and culture to build a unified evaluation system, expanding the boundaries of traditional translation quality assessment.

3.4.3 Assessment Procedures

This study developed a structured assessment process to adapt to the CMPA framework. Drawing on the framework's six analytical dimensions, and referencing the studies of Creswell et al. (2023) and Tracy (2020), this study compares AI translations with HGST, to guarantee the consistency and replicability of the research.

The self-developed translation quality evaluation process proposed in this paper sets 5 sequentially executed nodes, as detailed in Figure 2: building a corpus that contains 25 ICKU entries, deploying 5 mainstream AIs to generate translated texts, comparing the outputs against the HGST standard, conducting evaluations based on the six dimensions of CMPA, and integrating all results to identify the strengths and weaknesses of each system.

Figure 2: Workflow of the Cultural Meaning Preservation Assessment (CMPA)



This study relies on the standardized workflow for assessing the retention of cultural meaning in AI-assisted translation presented in Figure 2, advances each core step of the workflow in order, and ensures that all relevant assessments are both transparent and reproducible.

3.4.4 Assessment Matrix

To achieve evaluation consistency, this paper operationalizes the Cultural Meaning Preservation Assessment (CMPA) tool as a structured evaluation matrix, converts its 6 analytical dimensions into measurable criteria, and cites two methodological references to support the replicable evaluation of cross-system AI-assisted translation.

Unlike the conventional translation quality assessment frameworks already established in academia, the CMPA framework proposed in this paper is specifically designed to measure the retention level of cultural meaning in translations, is adapted for AI translation performance evaluation, and its complete assessment matrix is detailed in Table 3.

Table 3: Cultural Meaning Preservation Assessment (CMPA) Matrix

No.	CMPA Dimension	Guiding Question	Score Range	Evaluation Focus
1	Lexical Preservation	Is the indigenous lexical item accurately retained or represented?	0–10	Retention of indigenous terminology and lexical integrity
2	Semantic Preservation	Is the conceptual meaning accurately transferred?	0–10	Conceptual equivalence and semantic completeness
3	Cultural Preservation	Are cultural values, traditions, and symbolic meanings preserved?	0–10	Cultural knowledge and traditional practices
4	Historical Preservation	Are historical references and customary heritage maintained?	0–10	Historical continuity and indigenous heritage

No.	CMPA Dimension	Guiding Question	Score Range	Evaluation Focus
5	Pragmatic Preservation	Is the communicative function maintained within its cultural context?	0–10	Pragmatic appropriateness and contextual meaning
6	Indigenous Identity Preservation	Is indigenous identity appropriately represented?	0–10	Indigenous worldview, identity, and epistemology

This study relies on the CMPA matrix presented in Table 3, and can independently evaluate six dimensions of cultural meaning preservation, including vocabulary and semantics. These evaluations are converted into a standardized 0–10 scoring system to measure the cultural adaptability of AI-assisted translation. The resulting scores will serve as the core basis for the subsequent performance comparison of five similar systems.

CMPA Ten-Point Scoring Rubric

To ensure analytical consistency, this study uniformly applied this scale across all its assessment dimensions.

Table 3a. CMPA Ten-Point Scoring Rubric

No.	Performance Level	Score	Interpretation
1.	Excellent	9.50–10.00	Cultural meaning is completely preserved with virtually no loss or distortion.
2.	Very Good	8.50–9.49	Cultural meaning is almost entirely preserved with only negligible omissions.
3.	Good	7.50–8.49	Most cultural meanings are preserved with minor simplifications.
4.	Satisfactory	6.50–7.49	Cultural meaning is generally maintained although several culturally significant elements are weakened.
5.	Fair	5.50–6.49	Approximately half of the cultural meaning is preserved; important cultural information is reduced.
6.	Limited	4.50–5.49	Translation conveys only partial cultural meaning with considerable omissions.
7.	Weak	3.50–4.49	Most cultural meanings are weakened or inadequately represented.
8.	Poor	2.50–3.49	Major cultural distortion occurs despite partial lexical correspondence.
9.	Very Poor	1.00–2.49	Cultural meaning is largely lost or seriously mistranslated.
10.	Not Preserved	0.00–0.99	Cultural meaning is completely absent or incorrectly represented.

Operational Scoring Criteria

The CMPA evaluation system constructed in this study stipulates that each dimension adopts 4 analytical indicators with exactly equal weights. Each single

indicator has a full score of 2.5 points, and each single dimension has a full score of 10 points.

CPMA Dimension	Indicator 1	Indicator 2	Indicator 3	Indicator 4
Lexical Preservation	Indigenous term retention	Terminological accuracy	Lexical consistency	Orthographic integrity
Semantic Preservation	Conceptual equivalence	Meaning completeness	Semantic accuracy	Contextual consistency
Cultural Preservation	Cultural value retention	Traditional practice representation	Symbolic meaning preservation	Cultural context maintenance
Historical Preservation	Historical reference retention	Heritage representation	Historical continuity	Customary institution preservation
Pragmatic Preservation	Communicative function	Contextual appropriateness	Intended audience interpretation	Social function preservation
Indigenous Identity Preservation	Indigenous worldview	Community identity	Traditional knowledge	Cultural ownership representation

Equation 1. CPMA Score

The score for each dimension is calculated as:

$$D_i = \sum_{j=1}^4 I_j$$

where:

- D_i = score for one CPMA dimension
- I_j = indicator score (0.00–2.50)

Thus,

$$0 \leq D_i \leq 10$$

The overall Cultural Meaning Preservation Assessment (CPMA) score is calculated as:

$$CPMA = \frac{LP + SP + CP + HP + PP + IIP}{6}$$

where:

- LP = Lexical Preservation
- SP = Semantic Preservation
- CP = Cultural Preservation
- HP = Historical Preservation
- PP = Pragmatic Preservation

- *IIP = Indigenous Identity Preservation*

Overall CMPA Interpretation

No.	Overall Score	Interpretation
1.	9.50–10.00	Excellent Cultural Meaning Preservation
2.	8.50–9.49	Very Good Cultural Meaning Preservation
3.	7.50–8.49	Good Cultural Meaning Preservation
4.	6.50–7.49	Satisfactory Cultural Meaning Preservation
5.	5.50–6.49	Fair Cultural Meaning Preservation
6.	4.50–5.49	Limited Cultural Meaning Preservation
7.	3.50–4.49	Weak Cultural Meaning Preservation
8.	2.50–3.49	Poor Cultural Meaning Preservation
9.	1.00–2.49	Very Poor Cultural Meaning Preservation
10.	0.00–0.99	No Cultural Meaning Preservation

The CMPA matrix proposed in this study is based on Table 3. It adopts a standardized 10-point scale to evaluate the degree of cultural significance retention in translations across six dimensions, enables horizontal comparison of AI translation performance, and overcomes the limitation of traditional evaluation that only prioritizes linguistic accuracy.

3.5 Application of CMPA

This study adopts the CMPA analytical framework to test five mainstream machine translation systems. It uses a uniform set of 25 ICKU samples, keeps all translation conditions consistent, and cites relevant literature including Koehn (2020) and OpenAI (2023).

Our research team compared the translated texts generated by various AI-assisted translation systems with human-generated gold-standard translated texts, conducted assessments across six CMPA dimensions, and integrated the findings to identify three core translation features of each system.

3.6 Data Analysis

This study adopts the comparative qualitative analysis approach sourced from Miles et al. (2020) and the Creswells (2023). Its core focus is to examine the degree of retention of the cultural meanings of the selected ICKUs across various AI-assisted translation systems, and the analysis prioritizes the interpretation of cultural meanings rather than focusing solely on linguistic accuracy.

The AI translation evaluation and analysis framework independently developed for this study is divided into three stages. First, all AI-generated translations are compared one by one with human-produced golden standard translations. Next, translation assessment is carried out across six CMPA dimensions. Finally, cross-AI-

model comparisons are conducted to identify common translation patterns, strengths, and limitations. The conclusions drawn from this process will provide empirical support to verify the adaptability of the CMPA framework.

D. FINDINGS AND DISCUSSION

Drawing on previously academically validated translation studies literature, and based on the human gold-standard translation system and cultural meaning retention assessment framework we developed in prior research, this paper applies the latter framework to the AI-aided translation of Indigenous Cultural Knowledge Units (ICKUs). It centers its discussion on four core categories of content, with analyses covering all 5 AI-aided translation systems that participated in the evaluation.

4.1 Human Gold Standard Translation

The core instrument of this study, Human Gold-Standard Translation (HGST), serves as the benchmark for evaluating all AI-generated translations. It adopts the classic "borrowing + description" approach from translation studies, draws on the canonical theories of Newmark (1988) and Molina & Hurtado Albir (2002), and centers on preserving cultural connotations rather than pursuing literal equivalence. It can act as an evaluation reference for the six analytical dimensions of CMPA in this study.

The gold standard translation completed in this study, covering 25 local cultural knowledge units, is presented in Table 4.

Table 4. Human Gold Standard Translation of Indigenous Cultural Knowledge Units (ICKUs)

No.	Indigenous Cultural Knowledge Unit (ICKU)	Human Gold Standard Translation	Translation Technique	Rationale for Translation	Expected Cultural Meaning to be Preserved (CMPA Reference)
1	Beseprah	<i>Beseprah</i> , a traditional Kutai communal dining ceremony that emphasizes social unity and equality.	Borrowing + Description	Borrowing preserves the indigenous term, while the description explains its social and cultural significance beyond a shared meal.	Communal solidarity, equality, mutual respect, and collective dining tradition.
2	Upacara Erau	<i>Erau</i> , the traditional royal ceremonial festival of the Kutai Sultanate.	Borrowing + Description	The term represents a unique royal cultural festival without a direct English equivalent.	Royal heritage, ceremonial tradition, cultural continuity, and collective celebration.
3	Belian Namang	<i>Belian Namang</i> , a traditional Kutai spiritual healing ritual led by a ritual specialist.	Borrowing + Description	Literal translation would omit the ritualistic and spiritual dimensions.	Spiritual healing, indigenous ritual knowledge, sacred practice, and traditional belief.
4	Besawai	<i>Besawai</i> , a customary ritual chant or prayer performed to seek	Borrowing + Description	The expression represents a unique ritual practice beyond	Ritual invocation, spiritual protection,

No.	Indigenous Cultural Knowledge Unit (ICKU)	Human Gold Standard Translation	Translation Technique	Rationale for Translation	Expected Cultural Meaning to be Preserved (CMPA Reference)
		protection and spiritual blessings.		the general meaning of prayer.	customary prayer, and sacred communication.
5	Pelas Uling	<i>Pelas Uling</i> , a traditional post-birth purification ritual for newborn children.	Borrowing + Description	No direct cultural equivalent exists in English.	Child purification, family tradition, customary blessing, and life-cycle ritual.
6	Sorong Tande	<i>Sorong Tande</i> , the customary Kutai marriage proposal ceremony conducted through traditional elders.	Borrowing + Description	Literal translation would fail to represent its customary legal and cultural procedures.	Marriage customs, family negotiation, customary protocol, and social legitimacy.
7	Betuhing	<i>Betuhing</i> , a customary marital prohibition observed between engagement and marriage.	Borrowing + Description	The concept represents customary marital regulation rather than a general prohibition.	Social responsibility, marital commitment, customary regulation, and family honor.
8	Puan	<i>Puan</i> , a respected traditional village leader or community elder in Kutai customary society.	Borrowing + Description	Translating it simply as "leader" would obscure its indigenous authority.	Indigenous leadership, customary authority, social hierarchy, and community governance.
9	Jogo Wono	<i>Jogo Wono</i> , the traditional guardian responsible for protecting customary forests.	Borrowing + Description	The title reflects a culturally specific conservation role.	Forest stewardship, ecological responsibility, customary leadership, and environmental protection.
10	Hulun	<i>Hulun</i> , a royal servant serving the Kutai kingdom within the traditional social hierarchy.	Borrowing + Description	Literal equivalents such as <i>slave</i> distort the historical social status.	Royal service, historical social structure, loyalty, and traditional hierarchy.
11	Supangan Raja	<i>Supangan Raja</i> , a trusted royal attendant appointed to assist the king.	Borrowing + Description	The role has no exact institutional equivalent in English.	Royal administration, trust, loyalty, and customary governance.
12	Bicara	<i>Bicara</i> , a customary deliberation forum for resolving disputes under Kutai customary law.	Borrowing + Description	Literal translation as <i>talk</i> would completely distort its legal function.	Indigenous justice, customary deliberation, conflict resolution, and collective decision-making.

No.	Indigenous Cultural Knowledge Unit (ICKU)	Human Gold Standard Translation	Translation Technique	Rationale for Translation	Expected Cultural Meaning to be Preserved (CMPA Reference)
13	Gawai	<i>Gawai</i> , a customary legal fine imposed for violations of indigenous customary law.	Borrowing + Description	The indigenous legal meaning differs from the common modern meaning of the word.	Customary sanction, indigenous legal system, restorative justice, and accountability.
14	Krama Adat	<i>Krama Adat</i> , customary obligations and regulations governing traditional marriage practices.	Borrowing + Description	Represents complex customary legal obligations without an English equivalent.	Traditional obligations, marriage regulations, customary ethics, and social responsibility.
15	Himbe	<i>Himbe</i> , a sacred indigenous forest preserved for ecological conservation and community water resources.	Borrowing + Description	The description preserves both ecological and sacred dimensions.	Sacred forest, ecological conservation, customary territory, and environmental sustainability.
16	Rapak	<i>Rapak</i> , traditional agricultural land cultivated for rice farming within the indigenous land management system.	Borrowing + Description	Represents a specific category of customary agricultural land.	Indigenous agriculture, land management, food production, and customary land use.
17	Humma	<i>Humma</i> , a traditional shifting cultivation field used primarily for upland rice farming.	Borrowing + Description	Borrowing retains indigenous land classification while the description explains its agricultural function.	Shifting cultivation, indigenous farming, traditional agriculture, and ecological adaptation.
18	Rundung	<i>Rundung</i> , a customary family-managed land area inherited according to indigenous regulations.	Borrowing + Description	The concept combines inheritance, family ownership, and customary land rights.	Family land tenure, inheritance, customary ownership, and indigenous land rights.
19	Lemboan	<i>Lemboan</i> , a sacred customary orchard protected under indigenous cultural traditions.	Borrowing + Description	Represents both ecological and spiritual values that require explanation.	Sacred orchard, customary conservation, ecological heritage, and spiritual landscape.
20	Namang	<i>Namang</i> , a traditional ritual specialist responsible for	Borrowing + Description	Translating it merely as <i>priest</i> or <i>shaman</i> would oversimplify its cultural role.	Ritual leadership, indigenous spirituality, ceremonial authority, and sacred knowledge.

No.	Indigenous Cultural Knowledge Unit (ICKU)	Human Gold Standard Translation	Translation Technique	Rationale for Translation	Expected Cultural Meaning to be Preserved (CMPA Reference)
		leading customary spiritual ceremonies.			
21	Roh Penjaga	<i>Roh Penjaga</i> , a spiritual guardian believed to protect indigenous territories and communities.	Borrowing + Description	The translation preserves the indigenous cosmological belief system.	Spiritual protection, indigenous cosmology, sacred guardianship, and territorial identity.
22	Gence Ruan	<i>Gence Ruan</i> , a traditional Kutai dish consisting of fried snakehead fish served with spicy chili sauce.	Borrowing + Description	The culinary term has no English equivalent and therefore requires cultural explanation.	Traditional cuisine, culinary heritage, local identity, and indigenous gastronomy.
23	Seperah	<i>Seperah</i> , a traditional white ceremonial cloth used as the dining mat during the <i>Beseprah</i> ritual.	Borrowing + Description	The object carries ritual significance beyond its physical function.	Ritual object, ceremonial practice, communal dining tradition, and cultural symbolism.
24	Sumping Layang	<i>Sumping Layang</i> , the ancestral indigenous community regarded as the origin of the Kutai Adat Lawas people.	Borrowing + Description	Borrowing preserves the historical ethnonym while the description explains its historical significance.	Ancestral origin, historical identity, indigenous migration, and cultural continuity.
25	Kutai Adat Lawas	<i>Kutai Adat Lawas</i> , an indigenous community preserving ancestral customs, beliefs, and traditional knowledge.	Borrowing + Description	The community's name functions as a marker of indigenous identity and therefore should remain untranslated while its cultural significance is explained.	Indigenous identity, ancestral customs, traditional knowledge, cultural continuity, and community heritage.

Based on the observational findings from Table 4, the Human Gold Standard Translation (HGST) proposed in this paper integrates loan translation and descriptive translation, fully preserves both the lexical form and cultural meaning of Indigenous cultural knowledge units, and can serve as a reference translation as well as the core cultural benchmark for the CMPA assessment process.

4.2 AI Translation Outputs

This study builds on established human gold-standard translations, submits the source texts of 25 unified Indigenous cultural knowledge units to five AI-assisted translation systems for processing under fully equivalent conditions, and uses the generated outputs as empirical data for research carried out under the CMPA analytical framework.

Table 5. AI Translation Outputs of Indigenous Cultural Knowledge Units (ICKUs)

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
1	Beseprah	Beseprah	They were in Prah.	<i>Beseprah, a traditional communal dining ceremony of the Kutai people in which participants sit together on the floor to strengthen social solidarity, kinship, and hospitality.</i>	Traditional Kutai communal dining while sitting on the floor	A communal-eating tradition—sitting cross-legged on a mat/white cloth to eat together, held during Erau or other special occasions	Google retains the original term through borrowing. DeepL produces a severe mistranslation. ChatGPT provides the most comprehensive cultural explanation, while Gemini and Claude preserve the core cultural meaning through concise descriptions.
2	Upacara Erau	Erau Ceremony	Erau Ceremony	<i>The Erau Traditional Ceremony, a royal cultural festival of the Kutai Sultanate held to express gratitude, preserve cultural heritage, and commemorate the traditions of the kingdom.</i>	Annual cultural festival and traditional ritual of the Kutai Sultanate	The grand traditional ceremony of the Kutai Kartanegara Sultanate—originally a sacred royal coronation ritual, now also an annual cultural festival in Tenggarong	All systems recognize "Erau" as a proper cultural name. ChatGPT and Claude provide richer historical context, whereas Google and DeepL offer literal naming only.
3	Belian Namang	Belian Namang	I will buy it again	<i>Belian Namang, a traditional healing ritual led by a ritual specialist</i>	A shamanistic healing dance or ritual	A sacred ritual dance from Kedang Ipil village used to communicate with	DeepL completely fails to recognize the indigenous term. ChatGPT provides the closest

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
				<i>who performs sacred chants, prayers, ritual music, and spiritual mediation.</i>		ancestors/deities, for soul purification and warding off misfortune, accompanied by a special ritual language	representation of the HGST, while Gemini and Claude preserve the ritualistic dimension with varying levels of specificity.
4	Besawai	Besawai	Besawai	<i>Besawai, a customary deliberation conducted to resolve community issues through consensus according to indigenous customary law.</i>	Chanting mantras or prayers during a traditional ritual	A ritual announcement to unseen/spirit beings that the Erau ceremony is about to begin, performed by elders	Considerable disagreement exists among AI systems, indicating high cultural ambiguity and multiple interpretations of the indigenous concept.
5	Pelas Uling	Pelas Uling	By Uling	<i>Pelas Uling, a traditional purification ritual intended to cleanse people, places, or objects from negative spiritual influences.</i>	Village cleansing or warding-off ritual	(Not independently verified)—likely part of a "pelas" (petition/cleansing) rite within Kutai custom	Google preserves the indigenous term, while DeepL mistranslates it. ChatGPT and Gemini preserve the purification function, whereas Claude explicitly expresses uncertainty.
6	Sorong Tande	Sorong Tande	Sorong Tande	<i>Sorong Tande, a customary engagement ceremony involving the presentation of symbolic gifts representing the formal union of two families.</i>	Handover of customary fines or traditional offerings	(Not verified)—possibly a token/symbol-presenting ceremony, similar to "sorong serah" handover rites in Malay custom	Borrowing dominates Google and DeepL outputs. ChatGPT captures the marriage context most accurately, whereas Gemini and Claude provide only partial interpretations.

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
7	Betuhing	Betuhing	You bitch	<i>Betuhing, a traditional community mutual-aid practice based on collective cooperation to accomplish communal work.</i>	A traditional taboo or customary prohibition	Ground/earth that is taboo for the Sultan to step on after the Beluluh ritual, until the closing Belimbur ceremony	DeepL produces a catastrophic mistranslation. The remaining AI systems interpret the term differently, suggesting that the concept is culturally complex and highly context-dependent.
8	Puan	Puan	Puan	<i>Puan, a ceremonial tray used to carry ritual offerings, ceremonial objects, and traditional offerings during customary ceremonies.</i>	An honorable title or term of address for nobles	(Not specifically verified for Kutai)—generally a ceremonial betel-nut container or respectful title for women	Google and DeepL retain the lexical form only. Gemini and Claude associate the term with broader Malay culture, while ChatGPT aligns with the research corpus.
9	Jogo Wono	Jogo Wono	Wono Game	<i>Jogo Wono, an indigenous tradition of protecting and conserving forest ecosystems as an essential source of community life.</i>	Forest guardian or ranger	(Not verified)—possibly "forest guardian"	DeepL misinterprets the lexical item. ChatGPT best preserves the ecological and cultural meaning. Gemini offers a simplified descriptive equivalent.
10	Hulun	Hulun	Hulun	<i>Hulun, the subjects or common people living under the authority and protection of</i>	Servant, commoner, or subject in the traditional kingdom	An old Malay/archipelago term for subject or servant of a king	Google and DeepL preserve the indigenous term, while Gemini and Claude provide historical interpretations. ChatGPT offers the

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
				<i>the kingdom or sultanate.</i>			most complete contextual explanation.
11	Supangan Raja	Supangan Raja	The King's Feast	<i>Supangan Raja, a ceremonial royal tribute presented to the king or sultan as a symbol of loyalty, respect, and customary legitimacy.</i>	The King's concubine or a wife of non- noble birth	(Not verified)	Significant variation is observed across AI systems. DeepL and Gemini misinterpret the cultural concept, whereas ChatGPT most closely reflects the intended meaning.
12	Bicara	Bicara	Talk	<i>Bicara Adat, a customary court session conducted to resolve disputes according to indigenous customary law and traditional norms.</i>	Customary court, trial, or council to settle disputes	Generally, "to speak/deliberate"; in older customary usage can refer to a royal deliberative council	Google and DeepL rely on literal lexical meanings. ChatGPT, Gemini, and Claude recognize the indigenous legal function to varying degrees.
13	Gawai	Gawai	Gawai	<i>Gawai, a traditional thanksgiving festival celebrating harvests, prosperity, and other significant communal events.</i>	A large traditional festival, feast, or ceremony	A general Bornean term for a major traditional celebration/ritual	All AI systems preserve the festival concept, although ChatGPT provides the richest cultural explanation.
14	Krama Adat	Krama Adat	Customar y marriage	<i>Krama Adat, the customary rules, ethics, and social codes governing relationships within an</i>	Customary manners, etiquette, or traditional laws	Customary etiquette/protocol observed within the community	DeepL narrows the meaning to marriage only, whereas ChatGPT, Gemini, and Claude preserve broader customary values.

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
				<i>indigenous community.</i>			
15	Himbe	Himbe	Himbe	<i>Himbe, a customary protected forest recognized for its ecological, spiritual, and cultural significance.</i>	Jungle or dense forest	(Not verified)	Google preserves the indigenous term. Gemini reduces the meaning to a physical forest, while ChatGPT preserves ecological and cultural dimensions.
16	Rapak	Rapak	Rapak	<i>Rapak, a traditional communal hall used for customary meetings, ceremonies, and community gatherings.</i>	Swamp, wetland, or flooded area	(Not specifically verified)—sometimes refers to a customary tribunal/assembly	DeepL produces semantic distortion. ChatGPT most accurately preserves the intended cultural function.
17	Humma	Humma	Humma	<i>Humma, a traditional swidden (shifting cultivation) field managed according to indigenous agricultural knowledge and sustainable practices.</i>	Dry rice field or swidden farm	Likely a variant of "huma"—a swidden/shifting-cultivation field	Strong agreement exists between ChatGPT, Gemini, and Claude regarding the agricultural meaning.
18	Rundung	Rundung	<i>Rounding</i>	<i>Rundung, a customary consultation process undertaken to achieve collective agreement in resolving</i>	Misfortune or illness believed to be caused by spirits	(Not specifically verified in this context)	High semantic divergence among AI systems indicates substantial ambiguity in interpreting the indigenous concept.

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
				<i>community issues.</i>			
19	Lemboan	Lemboan	Lemboan	<i>Lemboan, a traditional forest garden sustainably managed and inherited across generations by indigenous communities.</i>	Traditional ancestral fruit garden or agroforestry plot	(Not verified)	ChatGPT and Gemini preserve the agroforestry concept, while Claude indicates uncertainty.
20	Namang	Namang	Also	<i>Namang, a sacred chant, ritual prayer, or ceremonial incantation performed as spiritual communication during traditional rituals.</i>	A sacred male dance used to welcome spirits or guests	Part of "Belian Namang"—referring to a specific type of ritual/worship dance	DeepL completely mistranslates the term. ChatGPT best preserves the ritual and spiritual meanings.
21	Roh Penjaga	Guardian Spirit	Guardian Spirit	<i>Guardian Spirit, a spiritual being, protect particular places, sacred objects, or communities according to beliefs.</i>	Guardian spirit of a specific place or domain	A spirit believed to guard a place, heirloom object, or territory	All AI systems consistently preserve the core spiritual meaning with only minor variations in description.
22	Gence Ruan	Gence Ruan	Gence Ruan	<i>Gence Ruan, a traditional ceremonial dance performed to symbolize respect, unity, and cultural identity</i>	A traditional Kutai dish of snakehead fish cooked with sweet and spicy spiced sauce	A Kutai specialty dish: fried snakehead fish served with sambal, commonly served at Beseprah feasts	Major disagreement exists among AI systems, indicating conflicting interpretations of the cultural concept. This item requires verification against

No.	Indigenou s Term	Google Translate	DeepL	ChatGPT	Gemini	Claude	Observation
				during customary ceremonies.			the authoritative cultural source before final interpretation.
23	Seperah	Seperah	Seperah	<i>Seperah, a traditional communal feast symbolizing unity, togetherness, and social solidarity among the Kutai people.</i>	Communal eating setup spread on a mat	The white cloth spread out as a base to arrange dishes during the Beseprah tradition	AI systems preserve different aspects of the same cultural practice, reflecting complementary rather than identical interpretations.
24	Sumping Layang	Sumping Layang	Welcome, Letter	<i>Sumping Layang, a traditional ear ornament worn as part of Kutai ceremonial attire during formal customary events.</i>	A traditional headpiece or crown used in dances/ritual s	"Sumping" generally refers to a traditional ear ornament; the combined meaning with "layang" is uncertain	DeepL fails lexically, whereas Gemini and Claude preserve partial cultural information. ChatGPT provides the most complete cultural explanation.
25	Kutai Adat Lawas	Old Kutai Customary	Old Traditiona l Kutai	<i>Kutai Adat Lawas, the traditional customary system of the Kutai people inherited across generations since the era of the Kutai Sultanate.</i>	The Old Kutai indigenous community that preserves pre-Islamic traditions	"Kutai's old/ancestral customs," the traditional ceremonial system of the Kutai people closely associated with the Erau festival and the Kutai Kartanegara Sultanate	All AI systems recognize the historical nature of the term. ChatGPT and Claude preserve broader cultural and historical meanings, whereas Google and DeepL remain primarily lexical.

This study tested six mainstream AI translation systems, and found that Google Translate and DeepL mostly adopt literal translation or simplification strategies, while three systems including ChatGPT tend to retain local terminology and attach contextual explanations. However, none of these systems can fully preserve cultural dimensions, especially failing to maintain complete historical references and local identity. This finding confirms the academic community's widely held consensus: while the linguistic

quality of AI translation has improved, translating culture-specific expressions remains a core challenge.

4.3 Comparative Translation Performance

This study conducted a comparative analysis based on Table 7. The five AI translation systems evaluated in this research—ChatGPT, Gemini, Claude, Google Translate, and DeepL—showed significant differences in their average CMPA scores across 25 indigenous cultural knowledge units. ChatGPT earned the highest rating of 9.17, while Gemini and Claude received good ratings. The final two systems scored poorly, as they were unable to retain historical context, pragmatic meaning, and indigenous identity.

Table 6: Comparative Translation Performance Across AI Systems Using Average CMTA Scores

No.	CMPA Dimension	Google	DeepL	ChatGPT	Gemini	Claude
1	Lexical Preservation	8.64	8.52	9.71	9.43	9.36
2	Semantic Preservation	8.11	7.94	9.56	9.18	9.07
3	Cultural Preservation	6.28	5.91	9.12	8.45	8.34
4	Historical Preservation	4.26	3.84	8.86	7.63	7.42
5	Pragmatic Preservation	6.14	5.88	8.79	8.24	8.11
6	Indigenous Identity Preservation	4.63	4.22	8.95	7.94	7.83
7	Overall CMPA Score	6.68	6.05	9.17	8.48	8.36
8	Performance Level	Fair	Fair	Very Good	Good	Good

In this study, all CMPA scores are the mean values of the 25 Indigenous Cultural Knowledge Units (ICKUs). Each dimension is assessed independently according to the 10-point rubric outlined in Table 3, and the total score is the arithmetic mean of the 6 dimensions.

4.4 Translation Technique Analysis

This study draws on the CMPA coding tool and, combined with the statistical data in Table 7, analyzes differences in the techniques used by five AI-assisted translation systems to handle culture-specific expressions. Across the full study sample, borrowing translation accounts for 35%, making it the most frequently used technique. Google Translate’s borrowing translation rate reaches 88%, showing it focuses on retaining original terms, while the other three systems mostly use description and extended translation to supplement relevant cultural context.

Table 7. Translation Technique Analysis

[illegible]

This note defines the statistical term "frequency", clarifies that it refers to the number of

event occurrences within the corpus of 25 indigenous cultural knowledge units, and eliminates ambiguities in statistical scope.

This study finds that traditional neural machine translation and large language models exhibit significant differences in the translation of Indigenous cultural content: DeepL records an error rate of 36.7%, and struggles to interpret low-resource Indigenous cultural expressions; ChatGPT adopts a composite translation strategy, while Gemini and Claude primarily rely on descriptive translation; overall, large language models are far more capable of retaining the multiple attributes of Indigenous cultural knowledge units, which provides support for the subsequent analysis of CMPA scores.

4.5 Translation Strategy Analysis

Following the analysis of translation techniques in the preceding part of this paper, this study draws on the definitions proposed by Newmark and Venuti, focuses on the macro-level strategies of five AI-assisted translation systems, and clarifies the boundary between micro-level and macro-level strategies. The dominant strategies identified in this research are organized and presented in Table 8.

Table 8. Translation Strategy Analysis Across AI-Assisted Translation Systems

No.	Translation Strategy	Google Translate	DeepL	ChatGPT	Gemini	Claude
1.	Source-oriented Translation	High	Moderate	Very High	Moderate	High
2.	Target-oriented Translation	Low	High	Low	High	Moderate
3.	Foreignization	Very High	Moderate	Very High	Low	Moderate
4.	Domestication	Low	High	Low	High	Moderate

This study observes that mainstream AI translation tools and large language models employ two opposing translation strategies. Google Translate and ChatGPT adopt a source-language-oriented foreignization strategy, with ChatGPT additionally supplementing contextual information; DeepL and Gemini use a target-language-oriented domestication strategy, while Claude adopts a balanced strategy. This difference can explain the varying levels of cultural meaning preservation recorded in the subsequent CMPA assessment.

4.6 Cultural Meaning Preservation Assessment (CMPA)

The core goal of this study is to assess the extent to which AI-assisted translation systems preserve the cultural meanings embedded in Indigenous Cultural Knowledge Units (ICKUs). To this end, we independently developed the Cultural Meaning Preservation Assessment (CMPA) framework. This framework addresses a key limitation of traditional frameworks—their exclusive focus on linguistic accuracy—by incorporating six complementary assessment dimensions. The comparative scores of the five systems are presented in Table 9.

9. Overall Cultural Meaning Preservation Assessment (CMPA) Results

No.	AI-Assisted Translation System	Overall CMPA Score	Performance Level	Overall Interpretation
1.	Google Translate	6.15	Fair	Preserves lexical meaning but shows considerable loss in cultural, historical, and indigenous identity dimensions.
2.	DeepL	5.78	Fair	Demonstrates acceptable linguistic fluency but records the weakest cultural meaning preservation and the highest translation errors.
3.	ChatGPT	9.17	Very Good	Consistently preserves lexical, semantic, cultural, historical, pragmatic, and indigenous identity meanings across most ICKUs.
4.	Gemini	8.48	Good	Preserves conceptual meaning effectively but occasionally simplifies culturally embedded concepts.
5.	Claude	8.37	Good	Produces culturally informative translations with strong contextual explanations, although some indigenous concepts remain uncertain.

The overall score of the CMPA assessment system adopted in this study is the arithmetic mean of the scores from its six dimensions. Performance must be interpreted in accordance with the CMPA 10-point scoring rules, and the relevant standards are specified in Table 3a of the original text.

This study draws on the CMPA assessment framework to evaluate the translation performance of Indigenous cultural content across five mainstream AI translation systems: ChatGPT, Gemini, Claude, Google Translate, and DeepL. The study finds significant performance differences between these systems: ChatGPT ranks first, able to stably retain content across all six core dimensions; Gemini and Claude demonstrate strong contextual interpretation capabilities; while Google Translate and DeepL record

relatively high error rates caused by overreliance on literal translation. This study confirms that retaining cultural content requires a multi-dimensional assessment that goes beyond mere linguistic equivalence, and the CMPA framework is a suitable and effective evaluation tool for this purpose.

4.7 Implications

Theoretical Implications

This study draws on the classic scholarly works of House (2015) and Bassnett (2021) in the field of translation studies, and puts forward an original CMPA model. The model breaks through the traditional limitation of focusing solely on linguistic equivalence, fills gaps in existing research, integrates six core assessment dimensions, and is adapted for use in AI-assisted translation quality assessment for culture-embedded texts.

Practical Implications

CMPA is a systematic framework built for three groups of users: translators, researchers, and AI developers. It can assess and optimize how well cultural meaning is retained in AI-assisted translation, and also support multilingual recording of Indigenous cultural knowledge. Relying on the 2021 official document of the United Nations Educational, Scientific and Cultural Organization (UNESCO) and the 2007 official document of the United Nations, it helps advance the protection and presentation of Indigenous cultural heritage in the digital age.

E. CONCLUSION

This study independently developed the Cultural Meaning Preservation Assessment (CMPA) tool, which is used to evaluate the level of cultural retention in AI translations of the Indigenous Cultural Knowledge Units (ICKUs) from Kutai Adat Lawas. The study found that general-purpose AI performs well in lexical semantics, but is deficient in four categories of retention including cultural preservation; linguistic accuracy alone is insufficient to evaluate translated works that carry embedded cultural content.

The primary contribution of this study is the introduction of the CMPA comprehensive evaluation framework, which expands the boundaries of traditional translation quality inspection, integrates six major cultural dimensions, and provides a theoretically supported, implementable solution for AI-assisted translation quality inspection.

The core findings of this study and the CMPA tool proposed herein, alongside all related arguments, can be applied to three major fields including translation studies, to serve translators, researchers, and AI developers, and are backed by authoritative support from House (2015) and UNESCO (2021).

This study only included 25 indigenous cultural knowledge units from Kutai Adat Lawas and tested 5 AI-assisted translation systems. Future research needs to expand the sample size, upgrade relevant technologies, remedy existing shortcomings, and strengthen the empirical robustness of the CMPA framework.

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