

AI-Enabled Sustainable Indigenous Heritage: Integrating Language Revitalization, Cultural Memory, and Digital Humanities in Taiwan

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1

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Abstract

The rapid decline of indigenous languages poses a significant challenge to cultural heritage preservation worldwide. This study argues that indigenous language preservation should be understood as a process of cultural revitalization rather than merely linguistic documentation.

Using Taiwan's indigenous languages as a representative case, the study explores how artificial intelligence (AI) can support indigenous cultural sustainability. Drawing from Indigenous Studies, Cultural Sustainability, Digital Humanities, and AI research, it develops an interdisciplinary framework linking language revitalization, knowledge transmission, community participation, and technological innovation.

The paper proposes the AI-Supported Indigenous Cultural Revitalization Framework (AICRF) and further develops the AI-Enabled Sustainable Indigenous Heritage Model

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(AI-SIHM). These models illustrate how AI technologies—including speech recognition, natural language processing, machine translation, large language models, and digital storytelling—can facilitate language preservation, cultural transmission, and indigenous heritage sustainability.

The findings suggest that AI should serve as a supportive tool rather than a replacement for indigenous knowledge holders. Effective AI-assisted cultural revitalization requires Indigenous Data Sovereignty, ethical governance, and community participation. The study contributes to the literature by integrating cultural sustainability theory with indigenous knowledge systems and proposing AI-SIHM as a multidisciplinary framework for future research and practice. It concludes that AI, when guided by indigenous self-determination, can become a catalyst for safeguarding indigenous heritage and promoting sustainable cultural futures.

Keywords: Indigenous Languages; Cultural Revitalization; Cultural Sustainability; Artificial Intelligence; Indigenous Knowledge Systems; Digital Humanities; Indigenous Data Sovereignty; Taiwan

1. Introduction

1.1 Language as Living Cultural Heritage

Language is more than a communication tool; it embodies collective memory, cultural identity, traditional knowledge, spiritual beliefs, and community values. For indigenous peoples, language serves as a living repository through which oral traditions, rituals, stories, and ecological knowledge are transmitted across generations. Therefore, language loss represents not only linguistic decline but also the erosion of cultural heritage and unique worldviews (Crystal, 2000).

Language embodies collective memory, cultural identity, and traditional knowledge (Crystal 2000; Harrison 2007). UNESCO (2023) reports that nearly half of the approximately 7,000 languages spoken worldwide are currently endangered, highlighting the urgent need for language preservation and revitalization initiatives. Globalization, urbanization, migration, and the dominance of national languages have accelerated the decline of many indigenous languages (UNESCO, 2023). As elder speakers disappear and younger generations adopt dominant languages, linguistic and cultural heritage faces increasing risks.

Within cultural sustainability, language plays a central role because it enables the transmission of knowledge, identity, and cultural practices across generations (Soini & Dessein, 2016). Consequently, preserving indigenous languages has become both a cultural and ethical responsibility, closely linked to community resilience and cultural continuity (Harrison, 2007).

1.2 Indigenous Languages and Cultural Heritage in Taiwan

Taiwan is recognized as an important center of Austronesian linguistic diversity. Many scholars regard Taiwan as a key homeland of Austronesian languages because numerous language branches can be traced back to the island (Blust, 2013).

Taiwan officially recognizes sixteen indigenous peoples, each possessing distinct linguistic and cultural traditions. Despite growing governmental support and revitalization programs, many indigenous languages remain endangered due to declining speaker populations, limited intergenerational transmission, and historical assimilation policies.

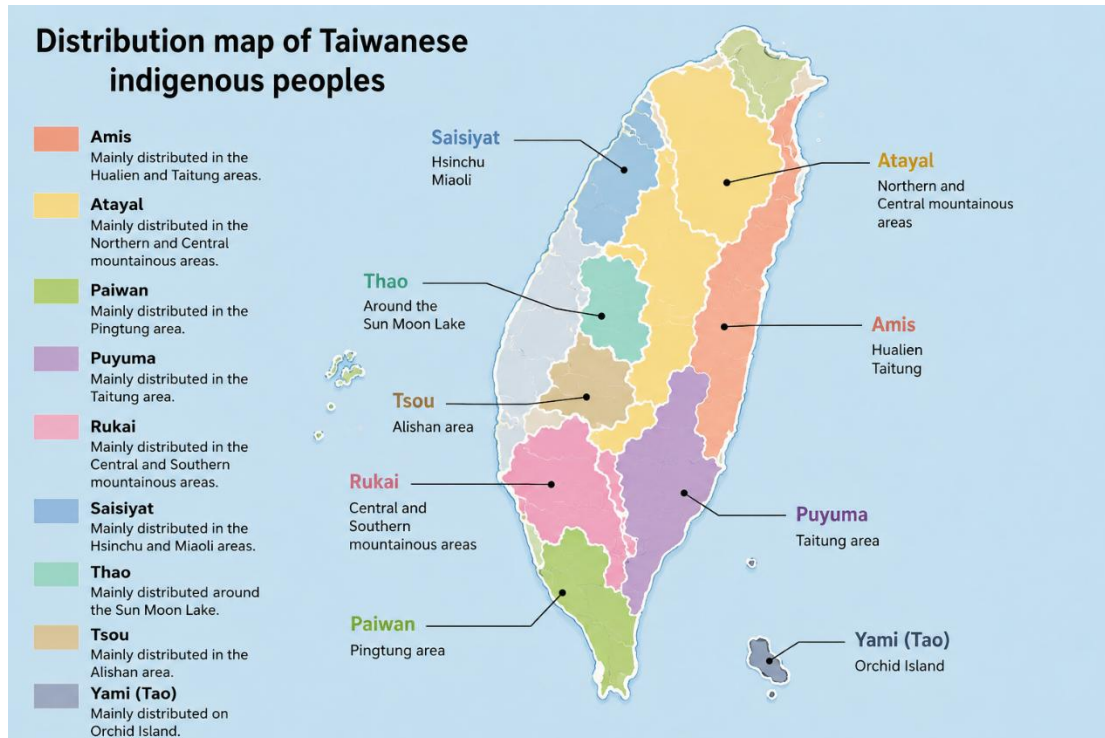


Figure 1. Distribution of Indigenous Peoples and Indigenous Language Groups in Taiwan.

Although language revitalization efforts have expanded through schools, cultural organizations, and government initiatives, younger generations often have limited opportunities to use indigenous languages in everyday life. The dominance of Mandarin Chinese in education and digital communication has further reduced their functional use.

The decline of indigenous languages also threatens broader cultural systems, including oral history, traditional ecological knowledge, ceremonial practices, and community values. As language use decreases, the long-term sustainability of indigenous cultural heritage becomes increasingly vulnerable.

1.3 From Language Preservation to Cultural Revitalization

Traditional language preservation efforts have focused largely on documentation, including dictionaries, grammar descriptions, recordings, and archival collections. While important, these approaches often treat language as an object of preservation rather than a living social practice.

Recent scholarship emphasizes a broader perspective that connects language revitalization with cultural revitalization, community empowerment, and indigenous

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self-determination (Smith, 2021). From this viewpoint, successful revitalization should strengthen cultural identity, knowledge transmission, and community resilience in addition to increasing speaker numbers.

Language revitalization has increasingly been linked to cultural revitalization and indigenous self-determination (Fishman 2001; McCarty and Nicholas 2014; Smith 2021). Language exists within a larger cultural ecosystem involving social relationships, educational institutions, cultural practices, and digital environments. Therefore, revitalization efforts must address these interconnected dimensions.

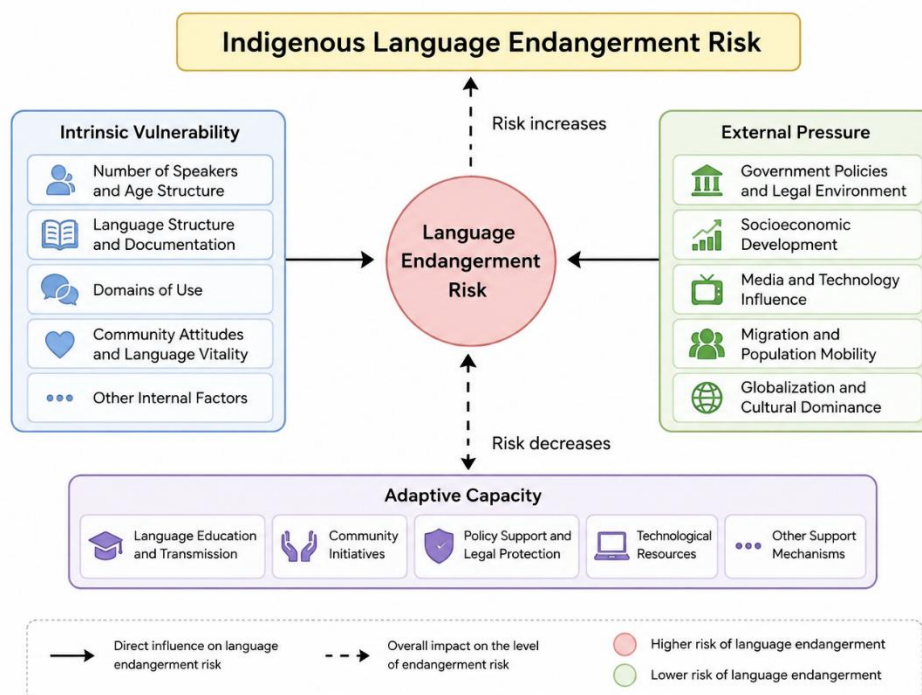


Figure 2 Relationship between Indigenous Language Use and Cultural Knowledge Transmission.

Figure 2 illustrates that increased indigenous language use supports intergenerational cultural knowledge transmission, while declining language use may accelerate cultural erosion and weaken indigenous knowledge systems.

1.4 Artificial Intelligence and the Future of Indigenous Heritage

Recent advances in artificial intelligence (AI), including natural language processing, speech recognition, machine translation, and large language models, have created new opportunities for indigenous language revitalization. These technologies can support

language documentation, oral history preservation, educational content development, and interactive learning environments.

AI also enables the integration of language learning with storytelling, traditional songs, oral narratives, and community-based knowledge sharing. However, technological innovation alone cannot ensure successful cultural revitalization. Issues related to Indigenous Data Sovereignty, intellectual property rights, cultural ownership, and community governance remain essential considerations (Kukutai & Taylor, 2016).

This study therefore proposes a framework linking artificial intelligence, indigenous language revitalization, and cultural sustainability. Using Taiwan's indigenous languages as a case, the research argues that AI should be viewed as a catalyst for cultural revitalization, supporting knowledge transmission, community participation, and cultural resilience while respecting indigenous self-determination and governance. (Bird 2020) (Mager et al. 2021) (Kukutai and Taylor 2016)

2. Literature Review

2.1 Language Endangerment and Cultural Loss

The disappearance of indigenous languages is one of the most significant cultural challenges of the twenty-first century. UNESCO (2023) reports that many minority languages are threatened by declining speaker populations, weak intergenerational transmission, migration, and the dominance of global languages. Language loss represents not only a linguistic phenomenon but also the erosion of cultural memory, identity, ecological knowledge, and spiritual traditions.

Crystal (2000) argues that each language embodies a unique worldview developed through generations of cultural experience. Similarly, Harrison (2007) notes that endangered languages often contain valuable knowledge regarding biodiversity, environmental management, and traditional practices. For indigenous communities, language serves as a primary medium for transmitting oral traditions, ceremonies, and collective values.

Taiwan occupies a significant position in Austronesian linguistic history (Blust 2013; Li 2015). Research further suggests a strong relationship between language vitality and cultural sustainability. Active language use within families, schools, and communities supports cultural continuity, whereas language decline often weakens cultural participation and knowledge transmission (Fishman 2001). Therefore,

language revitalization should be understood as a broader process of sustaining living cultural heritage. (Crystal 2000), (Harrison2007), (Fishman 2001), (UNESCO 2011, 2023)

2.2 Cultural Sustainability and Indigenous Knowledge Systems

Cultural sustainability has increasingly been recognized as the fourth pillar of sustainable development alongside environmental, economic, and social sustainability (Hawkes 2001). It refers to the ability of communities to maintain and transmit cultural identities, values, and knowledge across generations while adapting to social change (Soini & Dessein 2016).

Within this framework, indigenous knowledge systems—including traditional ecological knowledge, oral histories, spiritual beliefs, and governance practices—play a central role (Battiste 2013). Because much of this knowledge is embedded within indigenous languages, language decline often threatens cultural continuity.

Scholars have argued that language revitalization contributes to identity formation, social cohesion, and community resilience (McCarty & Nicholas 2014). In Taiwan, indigenous languages remain closely connected to Austronesian cultural heritage, traditional rituals, songs, myths, and ecological knowledge. Consequently, language revitalization supports broader goals of cultural preservation and indigenous self-determination. (Hawkes2001), (Soini & Dessein 2016), (Duxbury et al. 2017)

2.3 Artificial Intelligence and Endangered Language Revitalization

Recent advances in artificial intelligence (AI) have created new opportunities for endangered language revitalization. AI technologies—including speech recognition, machine translation, automatic transcription, and educational applications—enable more efficient documentation and use of indigenous languages in digital environments (Bird 2020).

Natural Language Processing (NLP) has become particularly important for developing digital dictionaries, translation systems, and language-learning platforms. Recent developments in large language models (LLMs) further support conversational learning and culturally relevant educational content (Mager et al. 2021).

Speech recognition technologies also facilitate the preservation of oral histories, songs, and narratives held by indigenous elders. In addition, AI-powered mobile

applications, chatbots, and digital learning environments provide younger generations with new opportunities to engage with indigenous languages.

Nevertheless, scholars emphasize that AI should complement rather than replace community-centered revitalization efforts. Successful implementation requires integration with local knowledge, community participation, and indigenous governance structures. (Radford et al.2023)

2.4 Indigenous Data Sovereignty and Ethical Considerations

As AI becomes increasingly involved in indigenous language preservation, concerns regarding data ownership, cultural rights, and governance have gained importance.

Indigenous Data Sovereignty (IDS) refers to the right of indigenous peoples to control the collection, ownership, access, and use of data relating to their communities and cultures (Kukutai & Taylor 2016). In AI-based revitalization projects, linguistic and cultural materials—including oral histories and traditional narratives—may be vulnerable to misuse if appropriate protections are not established.

The CARE Principles for Indigenous Data Governance—Collective Benefit, Authority to Control, Responsibility, and Ethics—provide an important ethical framework (Carroll et al. 2020). These principles emphasize community authority over cultural knowledge and data management.

Accordingly, indigenous communities should participate not only as data contributors but also as decision-makers regarding technological development, cultural representation, and knowledge governance. AI-assisted revitalization must therefore be guided by cultural respect, informed consent, and indigenous self-determination. Parsons & Carroll (2020)

2.5 Digital Humanities and the Future of Cultural Revitalization

Digital Humanities combines computational technologies with humanities research to support cultural preservation, interpretation, and knowledge production (Berry 2012). Within indigenous studies, digital humanities approaches have been widely applied to language documentation, oral history preservation, and community-based heritage projects.

The integration of AI and Digital Humanities offers significant opportunities for cultural revitalization. AI-powered digital archives, interactive storytelling platforms,

virtual museums, and language-learning applications help preserve and disseminate indigenous knowledge while engaging younger generations.

From this perspective, AI should not be viewed solely as a tool for language preservation. Rather, it can serve as a catalyst for cultural revitalization by supporting knowledge transmission, community participation, and cultural sustainability in digital societies.

Accordingly, this study adopts a cultural revitalization perspective that links language, identity, indigenous knowledge, technology, and community sustainability. This theoretical foundation supports the AI-based cultural revitalization framework proposed in the following sections. Svensson (2016)

3. Conceptual Framework and Research Design

3.1 Research Paradigm

This study adopts an interdisciplinary perspective integrating Indigenous Studies, Cultural Sustainability, Digital Humanities, and Artificial Intelligence. Rather than treating language preservation as a purely linguistic activity, the study views indigenous language revitalization as a broader process of cultural revitalization involving identity, knowledge transmission, community participation, and technological innovation.

The research is based on three assumptions:

1. Language is a primary carrier of cultural knowledge and collective memory.
2. Cultural sustainability depends on intergenerational transmission of indigenous knowledge.
3. Artificial intelligence can support cultural revitalization when implemented through community-centered and ethical governance frameworks.

Based on these assumptions, the study develops a conceptual model linking language preservation, cultural knowledge transmission, community participation, and technological innovation within a sustainable cultural ecosystem.

3.2 Indigenous Languages in Taiwan: Current Challenges

Taiwan's Indigenous peoples represent an important branch of the Austronesian language family, and the island is widely regarded as a crucial center in Austronesian linguistic history (Blust, 2013). However, despite ongoing government support and

formal legal recognition, many Indigenous languages in Taiwan continue to face significant challenges. These include a steady decline in the number of fluent speakers, noticeable gaps in intergenerational language transmission, and a limited presence in digital spaces. In addition, the pressures of globalization and cultural assimilation further contribute to the marginalization of these languages. Collectively, these factors intensify the risk of language endangerment and reduce opportunities for the transmission of cultural knowledge across generations.

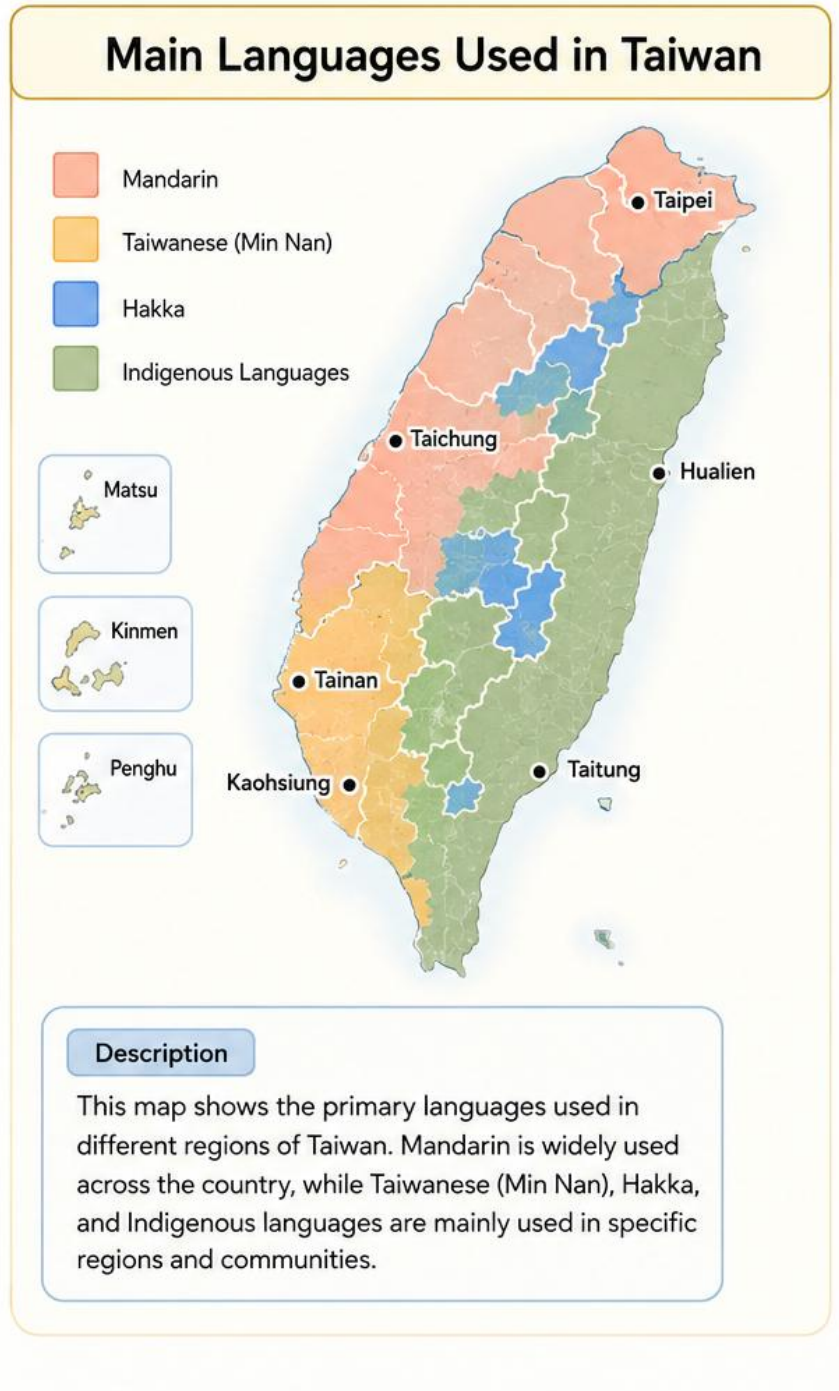


Figure 1. Distribution of Indigenous Peoples and Indigenous Language Groups in Taiwan.

Source: Adapted from Taiwan Council of Indigenous Peoples.

3.3 Language Use and Cultural Knowledge Transmission

Language serves as a key mechanism for transmitting oral traditions, ecological knowledge, rituals, kinship systems, and collective memory. As language use declines, opportunities for cultural transmission also decrease. Conversely, increased language use strengthens cultural identity and community engagement.

Figure 2 illustrates the positive relationship between indigenous language use and cultural knowledge transmission.

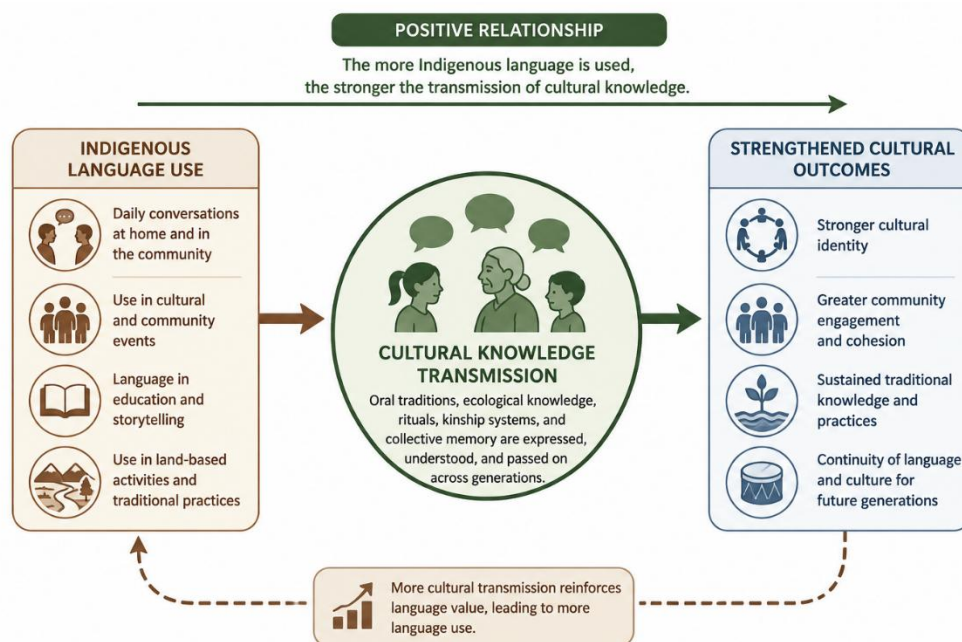


Figure 2. Relationship between Indigenous Language Use and Cultural Knowledge Transmission.
Source: Developed by the authors.

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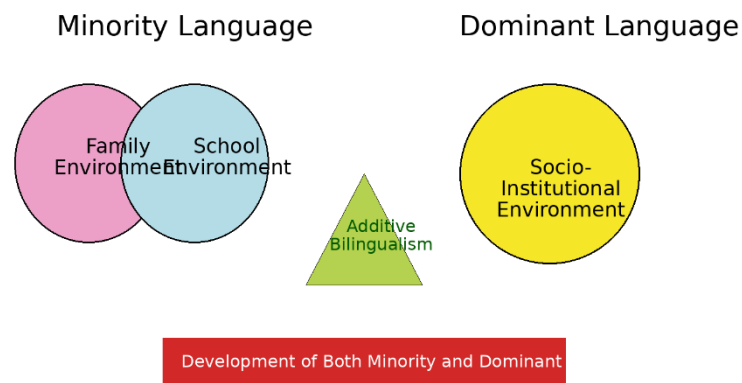
The model suggests that higher levels of language use enhance intergenerational communication and cultural learning, thereby supporting cultural sustainability.

3.4 Indigenous Language Endangerment Risk Framework

Building upon existing studies of language vitality and cultural sustainability, this research proposes an Indigenous Language Endangerment Risk Framework that conceptualizes language risk through three interrelated dimensions. The first dimension, intrinsic vulnerability, focuses on the internal conditions of the language and its speaker community. This includes factors such as the number of speakers, the distribution of speakers across age groups, and the overall vitality of the language. It also considers the domains in which the language is actively used—such as in the home, education, or community settings—as well as the attitudes of community members toward their own language. Together, these elements shape the baseline resilience or fragility of the language.

The second dimension addresses external pressure, highlighting the broader socio-political and economic forces that influence language use. Government policies can either support or marginalize minority languages, while economic development and urbanization often drive migration and language shift toward dominant languages. Additionally, the pervasive influence of mass media and the forces of globalization tend to privilege widely spoken languages, further reducing the functional space for Indigenous languages. These external pressures can accelerate language decline, even in communities with relatively strong internal foundations.

The third dimension, adaptive capacity, emphasizes the ability of communities to respond to and mitigate these challenges. This includes the presence and effectiveness of language education programs, grassroots community initiatives aimed at language maintenance or revitalization, and the use of technological resources such as digital platforms and language documentation tools. Policy support at local or national levels also plays a crucial role, as do broader cultural revitalization efforts that reinforce the connection between language and identity. Taken together, this framework integrates key insights from prior research on language vitality, language shift, and endangered language assessment (Fishman 1991; Grenoble and Whaley 2006; Simons and Lewis 2013), offering a multidimensional and dynamic approach to understanding Indigenous language endangerment.



Additive Bilingualism (Allard & Landry, 1992)

Figure 3. Indigenous Language Endangerment Risk Framework.

Source: Developed by the authors.

The framework proposes that language endangerment increases when intrinsic vulnerability and external pressure exceed adaptive capacity. Strengthening adaptive capacity can therefore reduce extinction risks and enhance cultural resilience.

3.5 AI-Supported Indigenous Cultural Revitalization Framework (AICRF)

To address these challenges, this study proposes the **AI-Supported Indigenous Cultural Revitalization Framework (AICRF)**, which positions artificial intelligence within a broader cultural ecosystem.

The proposed framework is structured as five interconnected layers that together illustrate the dynamic relationship between language resources, technology, and cultural sustainability. The first layer, Indigenous Language Resources, represents the foundational knowledge base. It encompasses oral histories, traditional stories, songs and chants, as well as more formalized materials such as dictionaries and archival records. These resources embody the linguistic and cultural heritage that the framework seeks to preserve and revitalize.

Building upon this foundation, the second layer introduces AI technologies as key enablers for language preservation and accessibility. Technologies such as speech recognition, natural language processing, machine translation, large language models, and knowledge graphs provide powerful tools for documenting, analyzing, and revitalizing Indigenous languages. These innovations allow linguistic data to be transformed into usable and scalable digital formats, expanding their reach and

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functionality.

The third layer focuses on digital cultural platforms, which serve as the interface between technology and users. These platforms include mobile learning applications, chatbots, virtual museums, interactive storytelling systems, and community-based digital archives. Through these applications, language resources and AI capabilities are translated into engaging, user-friendly environments that facilitate learning, interaction, and cultural exchange.

At the fourth layer, community participation plays a central role in ensuring the relevance and sustainability of these efforts. Tribal elders, Indigenous educators, cultural organizations, youth learners, and researchers all contribute to the co-creation, validation, and transmission of knowledge. Their involvement helps maintain cultural authenticity while fostering intergenerational connections and active engagement with the language.

Finally, the fifth layer highlights cultural sustainability outcomes, which represent the broader impacts of the framework. These outcomes include language revitalization, the preservation of cultural knowledge, the strengthening of cultural identity, enhanced community resilience, and the promotion of sustainable cultural development. Together, these five layers form an integrated and mutually reinforcing system that supports the long-term vitality of Indigenous languages and cultures.

The development of the AICRF framework integrates insights from language revitalization studies (Fishman 2001), cultural sustainability theory (Hawkes 2001; Soini and Dessein 2016), indigenous knowledge systems (Battiste 2013), and AI-enabled language technologies (Bird 2020; Mager et al. 2021).

Figure 4. AI-Supported Indigenous Cultural Revitalization Framework (AICRF)

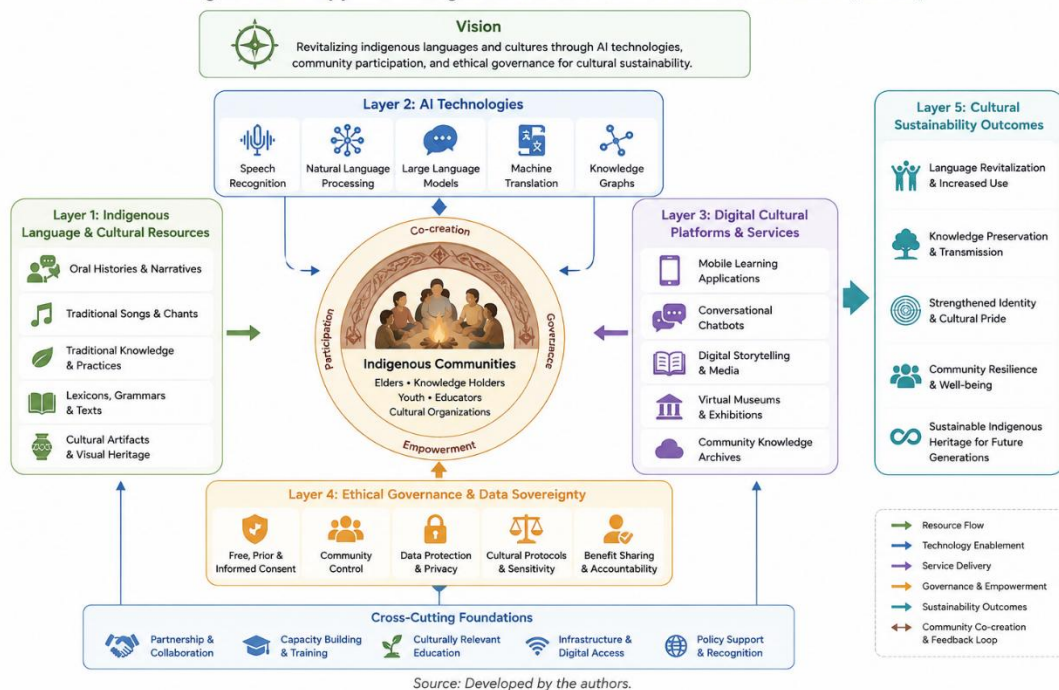


Figure 4. AI-Supported Indigenous Cultural Revitalization Framework (AICRF).

Source: Developed by the authors.

The AICRF framework views AI as a supporting mechanism rather than a replacement for indigenous knowledge holders. AI enhances access to linguistic and cultural resources, while community participation ensures cultural authenticity, ethical governance, and sustainable cultural outcomes.

3.6 Research Design

This study adopts a conceptual research design based on literature synthesis and framework development. The research process includes four stages:

1. Review of indigenous language revitalization literature.
2. Analysis of cultural sustainability and indigenous knowledge theories.
3. Examination of AI technologies relevant to endangered language preservation.
4. Development of the AI-Supported Indigenous Cultural Revitalization Framework (AICRF).

The resulting framework provides a theoretical foundation for future empirical studies and practical implementation projects. By integrating language preservation, cultural sustainability, digital humanities, and artificial intelligence, the study contributes a multidisciplinary perspective to indigenous heritage revitalization in the digital age.

4. AI Technologies for Indigenous Cultural Revitalization

4.1 Speech Recognition and Oral History Preservation

One of the greatest challenges facing indigenous communities is the loss of elder speakers who possess extensive linguistic and cultural knowledge. Much of this knowledge exists in oral forms, including stories, songs, rituals, ecological knowledge, and community histories.

Recent advances in large-scale speech recognition models have improved support for low-resource languages through transfer-learning approaches (Radford et al. 2023).

Artificial Intelligence-based Automatic Speech Recognition (ASR) technologies provide new opportunities for documenting and preserving these resources. Modern systems can automatically convert speech into text, significantly improving documentation efficiency.

Recent models such as Whisper, XLS-R, and wav2vec 2.0 can be adapted to low-resource indigenous languages through transfer learning approaches (Radford et al., 2023). In Taiwan, speech recognition can support oral history recording, preservation of ceremonial language, documentation of traditional songs, creation of digital archives, and future language education programs.

Beyond language preservation, ASR contributes to safeguarding intangible cultural heritage by transforming vulnerable oral knowledge into sustainable digital resources.

4.2 Natural Language Processing and Indigenous Language Documentation

NLP technologies have increasingly been applied to indigenous language documentation, corpus development, and machine translation (Bird 2020; Mager et al. 2021). Natural Language Processing (NLP) enables computers to analyze, understand, and generate human language. Compared with traditional documentation methods, NLP can accelerate corpus construction, lexical analysis, grammatical studies, and educational content development.

Major applications include:

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- **Digital Dictionary Development** through automated vocabulary extraction.
- **Morphological Analysis** for identifying grammatical structures in Austronesian languages.
- **Parallel Corpus Alignment** between indigenous languages, Mandarin Chinese, and English.
- **Language Learning Support** through adaptive educational materials and exercises.

The development of digital corpora provides an essential foundation for future AI-supported language revitalization and linguistic preservation.

18

4.3 Large Language Models and Indigenous Knowledge Systems

Large Language Models have demonstrated remarkable capabilities in multilingual language generation and knowledge retrieval (Russell and Norvig 2021; Radford et al. 2023). Large Language Models (LLMs), such as GPT, Llama, Claude, and Gemini, have significantly expanded the possibilities for indigenous language revitalization.

Potential applications include:

- Conversational language-learning systems.
- Indigenous knowledge retrieval platforms.
- Educational content generation.
- Cultural question-and-answer systems.

However, indigenous knowledge is often community-owned, context-dependent, and culturally sensitive. Therefore, AI systems must be developed under appropriate cultural protocols and governance structures.

Rather than replacing cultural experts, LLMs should function as supportive tools that improve access to knowledge while respecting indigenous authority and cultural ownership.

4.4 Digital Storytelling and Cultural Transmission

Digital storytelling has become an important methodology within digital humanities for preserving oral traditions and cultural memory (Berry 2012; Svensson 2016). Storytelling plays a central role in transmitting indigenous history, values, ecological knowledge, and identity. Digital storytelling combines traditional narratives with contemporary technologies to enhance cultural transmission.

AI can support interactive and immersive cultural transmission through the development of multilingual and voice-based storytelling systems, as well as virtual environments that enhance cultural learning experiences. These approaches connect language learning with meaningful cultural contexts, supporting holistic learning, cultural relevance, and community engagement.

4.5 AI, Cultural Sustainability, and Community Participation

Community participation remains essential for successful language revitalization initiatives (McCarty and Nicholas 2014; Wilson 2008). The success of AI-assisted cultural revitalization depends on meaningful community participation rather than technology alone. Indigenous scholars emphasize that revitalization initiatives should remain community-driven (McCarty & Nicholas, 2014).

Community participation may involve defining preservation priorities, contributing linguistic resources, reviewing cultural content, establishing governance protocols, and evaluating technological outcomes. Such participation enhances cultural legitimacy, strengthens local capacity, and promotes long-term sustainability. Communities become active creators rather than passive recipients of technological interventions.

The integration of AI and community participation therefore creates a collaborative model that combines traditional knowledge with technological innovation.

4.6 Ethical AI and Indigenous Data Sovereignty

Ethical AI governance should align with both UNESCO AI Ethics recommendations and Indigenous Data Sovereignty principles (UNESCO 2021; Kukutai and Taylor 2016).

Despite its benefits, AI raises important ethical concerns regarding ownership, consent, privacy, representation, and cultural authority.

Indigenous Data Sovereignty (IDS) asserts the right of indigenous peoples to control the collection, management, interpretation, and use of their data (Kukutai & Taylor, 2016).

Key ethical principles underpinning this framework emphasize the importance of respecting and protecting Indigenous rights and knowledge systems. Community consent is fundamental, ensuring that participation is voluntary and based on fully

informed agreement. Equally important is cultural ownership, whereby communities retain control over their linguistic and cultural resources rather than relinquishing them to external entities. Effective data governance mechanisms are also necessary to regulate how data is accessed, used, and shared, ensuring transparency and accountability. In addition, cultural sensitivity must be upheld, particularly in safeguarding sacred or restricted knowledge that requires special protection. Finally, the principle of shared benefits highlights that any technological outcomes derived from these efforts should directly support and benefit the participating communities, rather than serving solely external interests.

Ethical governance is essential for ensuring that AI contributes positively to indigenous cultural futures and avoids reproducing historical patterns of cultural extraction. Consequently, AI-assisted revitalization must be guided by respect, reciprocity, community empowerment, and indigenous self-determination.

AI Applications for Indigenous Cultural Revitalization Ecosystem



Source: Developed by the authors.

Figure 5. AI Applications for Indigenous Cultural Revitalization Ecosystem

Source: Developed by the authors.

Figure 5 illustrates how AI technologies contribute to indigenous cultural revitalization through a sequential ecosystem. AI supports language documentation and digital archiving, which in turn enable educational applications and community participation. These processes collectively strengthen cultural sustainability and long-term heritage preservation.

5. Discussion: From Language Preservation to Cultural Revitalization

5.1 Reframing Indigenous Language Preservation as Cultural Revitalization

Traditional language preservation has focused primarily on documentation, including dictionaries, grammar descriptions, and archives. While important, such approaches often treat language as an object of preservation rather than a living cultural practice.

This study argues that indigenous language preservation should be reframed as cultural revitalization. Language functions as a vehicle for transmitting collective memory, cultural identity, traditional knowledge, spiritual beliefs, and social values. This perspective aligns with Cultural Sustainability Theory, which emphasizes maintaining dynamic systems of cultural transmission rather than static artifacts (Soini & Dessein, 2016).

Therefore, the ultimate goal of language revitalization is not merely preserving linguistic forms but strengthening indigenous cultural futures.

5.2 Artificial Intelligence as a Cultural Enabler

This study proposes AI as a cultural enabler rather than merely a technological tool. AI can support language documentation, oral history preservation, cultural storytelling, knowledge transmission, educational innovation, and community engagement.

The AI-Supported Indigenous Cultural Revitalization Framework (AICRF) demonstrates how AI transforms cultural resources into accessible digital formats while maintaining community participation and cultural governance.

Accordingly, AI should be evaluated not only by technical performance but also by its contribution to cultural resilience, community empowerment, and cultural sustainability.

5.3 Indigenous Knowledge Systems and Cultural Sustainability

A major contribution of this study is the integration of Indigenous Knowledge Systems (IKS) with Cultural Sustainability Theory.

Indigenous knowledge is embedded in oral traditions, ceremonies, songs, and language. As language use declines, knowledge transmission may weaken, threatening cultural continuity.

This relationship can be understood as a continuous progression in which language serves as the foundation for knowledge, which in turn shapes identity, strengthens community cohesion, and ultimately sustains cultural continuity. AI can strengthen each stage of this cycle through digital archives, educational platforms, and knowledge-sharing systems. Consequently, AI contributes not only to language revitalization but also to sustaining indigenous knowledge systems as living cultural resources.

5.4 Community Participation and Indigenous Data Sovereignty

Technology alone cannot ensure successful cultural revitalization. Indigenous communities must remain central participants in revitalization initiatives (Kukutai & Taylor, 2016; Carroll et al., 2020).

The study emphasizes Indigenous Data Sovereignty (IDS) through four key principles, including community ownership, community governance, ethical representation, and the equitable sharing of benefits. These principles help ensure that AI remains aligned with indigenous values while supporting long-term cultural sustainability.

5.5 Toward an AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM)

Building upon the preceding discussion, this study proposes the **AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM)**.

The model integrates six dimensions:

1. Indigenous Language Resources
2. Artificial Intelligence Technologies
3. Digital Cultural Infrastructure
4. Community Participation
5. Indigenous Governance
6. Cultural Sustainability Outcomes

Together, these dimensions connect language revitalization, knowledge preservation, ethical governance, and sustainable cultural development.

The proposed AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM) synthesizes insights from cultural sustainability theory (Hawkes 2001; Soini and Dessein 2016), Indigenous Knowledge Systems (Battiste 2013; Smith 2021), Indigenous Data Sovereignty (Kukutai and Taylor 2016), and contemporary AI applications (Bird 2020; Radford et al. 2023).

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24

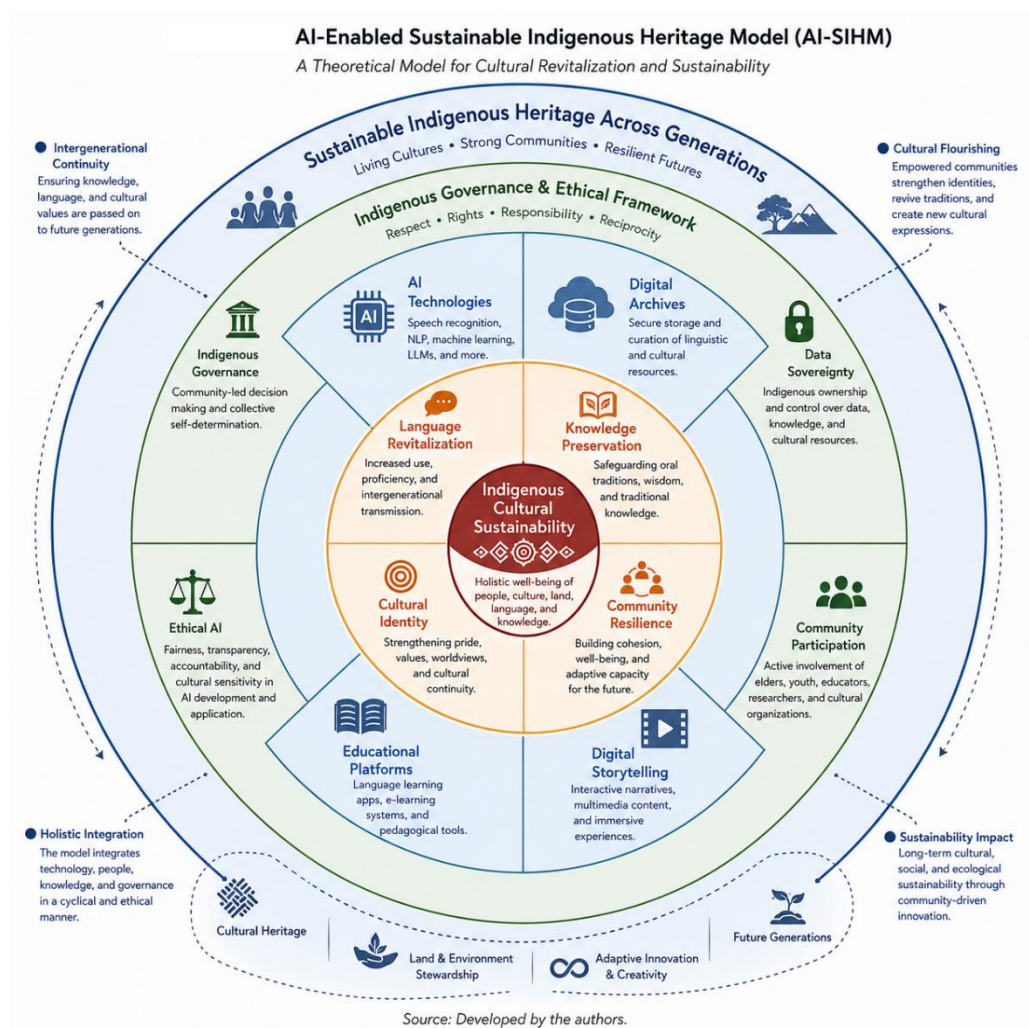


Figure 6. AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM).

Source: Developed by the authors.

Figure 6 illustrates how indigenous language resources are transformed through AI technologies and digital cultural infrastructure. Community participation and

indigenous governance guide this process, leading to language revitalization, identity strengthening, community resilience, and long-term cultural sustainability.

5.6 Indigenous Spirituality, Cultural Memory, and Digital Heritage

Cultural memory is maintained through oral traditions, rituals, and performances that connect communities with ancestral knowledge (Assmann 2011; Taylor 2003).

Indigenous revitalization extends beyond language preservation to include spirituality, cultural memory, and intangible cultural heritage. UNESCO (2003; 2023) recognizes oral traditions, rituals, songs, narratives, and traditional knowledge as essential components of living heritage.

Language serves as a carrier of sacred knowledge and spiritual traditions. Many indigenous concepts cannot be fully translated into dominant languages, making language revitalization crucial for preserving cultural meaning and worldview (Harrison, 2007).

Cultural memory is transmitted through oral traditions, ceremonies, songs, and ancestral teachings (Assmann, 2011). As language transmission declines, cultural memory may also weaken.

Digital technologies—including archives, virtual museums, storytelling platforms, and AI-assisted documentation—provide new opportunities for preserving intangible heritage. However, AI systems must respect Indigenous Data Sovereignty and community governance (Kukutai & Taylor, 2016; Carroll et al., 2020).

Within the AI-SIHM framework, this process can be understood as a continuum in which language forms the basis of knowledge, which contributes to cultural memory, shapes identity, strengthens community resilience, and ultimately supports cultural sustainability. Technology supports these processes, but cultural meaning continues to emerge through community participation and lived cultural experience.

5.7 Implications for Art, Religion, Culture, and Humanities

Art

Indigenous arts—including songs, dances, oral poetry, weaving, and ceremonial performances—are closely linked to language and cultural memory. AI-assisted

documentation can help preserve artistic heritage and performance traditions.(Taylor 2003)(Smith 2006)

Religion and Spirituality

Traditional ceremonies, ritual chants, and sacred narratives rely heavily on indigenous languages. Ethical AI governance is therefore essential to protect sacred and culturally restricted knowledge.(UNESCO 2003)

Culture and Identity

Language remains a key mechanism for maintaining cultural identity, traditional knowledge, and community continuity. AI-assisted revitalization can strengthen engagement with cultural heritage and support cultural renewal.(Sahlins 1999)

(Smith2006)

Digital Humanities

Humanities provides an interdisciplinary framework connecting technology, culture, and human experience (Berry, 2012; Svensson, 2016). The AI-SIHM model contributes to this field by demonstrating how AI can support sustainable cultural futures while respecting indigenous governance and cultural autonomy.(Berry 2012)(Svensson 2016)

5.8 Theoretical Contributions

This study makes three primary theoretical contributions:

1. Reframing language preservation as cultural revitalization.
2. Integrating Cultural Sustainability Theory and Indigenous Knowledge Systems into AI and digital heritage research.
3. Proposing the AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM) as a multidisciplinary framework connecting language, culture, technology, governance, and sustainability.

These contributions bridge Indigenous Studies, Digital Humanities, Cultural Sustainability, and Artificial Intelligence.

5.9 Implications for Future Research and Practice

The AI-SIHM model provides a valuable foundation for both future research and practical implementation in the field of Indigenous language and cultural sustainability. Building on this framework, future studies may focus on evaluating the effectiveness of AI applications within specific Indigenous communities, as well as assessing how learners perceive AI-assisted language learning tools. In addition, further research could explore the relationship between digital participation and the formation of cultural identity, while also investigating governance mechanisms related to Indigenous Data Sovereignty. Comparative analyses across different Indigenous populations may also offer important insights into the varying outcomes and strategies of language revitalization initiatives.

For policymakers and practitioners, the model highlights the importance of integrating technology with community participation, cultural governance, and sustainability objectives. Ultimately, sustainable indigenous heritage depends on both technological innovation and indigenous communities' ability to shape their own cultural futures.

6. Conclusion and Future Directions

6.1 Conclusion

This study examined how artificial intelligence can contribute to the preservation and revitalization of indigenous languages and cultural heritage in the digital age.

Rather than viewing language preservation solely as linguistic documentation, this research argues that indigenous language revitalization should be understood within a broader framework of cultural revitalization and cultural sustainability. Language serves not only as a communication system but also as a carrier of collective memory, traditional knowledge, cultural identity, spiritual beliefs, and social values.

Using Taiwan's indigenous languages as a representative case, the study explored the relationships among language vitality, cultural sustainability, indigenous knowledge systems, and emerging AI technologies. The findings indicate that speech recognition, natural language processing, digital archives, educational platforms, digital storytelling, and large language models can significantly support language preservation and cultural transmission.

However, technology alone cannot ensure cultural continuity. Successful revitalization requires meaningful community participation, Indigenous Data

Sovereignty, ethical governance, and culturally appropriate implementation strategies. AI should therefore be viewed as an enabling mechanism rather than a substitute for indigenous knowledge holders.

To address these issues, this study developed the **AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM)**, which integrates artificial intelligence, cultural sustainability, indigenous knowledge systems, digital humanities, and community governance into a unified framework.

The model conceptualizes indigenous heritage as a dynamic ecosystem in which language, knowledge, technology, governance, and community participation interact to support long-term cultural sustainability and indigenous self-determination.

The AI-SIHM model reflects broader discussions concerning cultural sustainability (Hawkes 2001; Soini and Dessein 2016), indigenous self-determination (Smith 2021), and ethical AI governance (UNESCO 2021).

6.2 Theoretical Contributions

This study contributes to the literature in three ways.

First Contribution: Reframing Language Preservation as Cultural Revitalization

The study extends traditional language preservation research by positioning language revitalization within a broader process of cultural revitalization, emphasizing the interconnections among language, identity, knowledge, and community sustainability.

Second Contribution: Integrating Artificial Intelligence with Cultural Sustainability Theory

The research bridges AI studies, Cultural Sustainability Theory, and Indigenous Knowledge Systems, expanding discussions of digital heritage and AI-assisted cultural preservation.

Third Contribution: Development of the AI-Enabled Sustainable Indigenous Heritage Model (AI-SIHM)

The AI-SIHM model represents the primary theoretical contribution of this study. It provides a multidisciplinary framework explaining how technology, governance, community participation, and cultural knowledge transmission interact to support sustainable indigenous heritage.

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The model offers a foundation for future empirical research and policy development in digital cultural preservation.

Figure 7 synthesizes perspectives from cultural sustainability theory (Hawkes 2001; Soini and Dessein 2016), cultural memory studies (Assmann 2011), heritage studies (Smith 2006), digital humanities (Berry 2012; Svensson 2016), and indigenous knowledge research (Battiste 2013; Smith 2021).

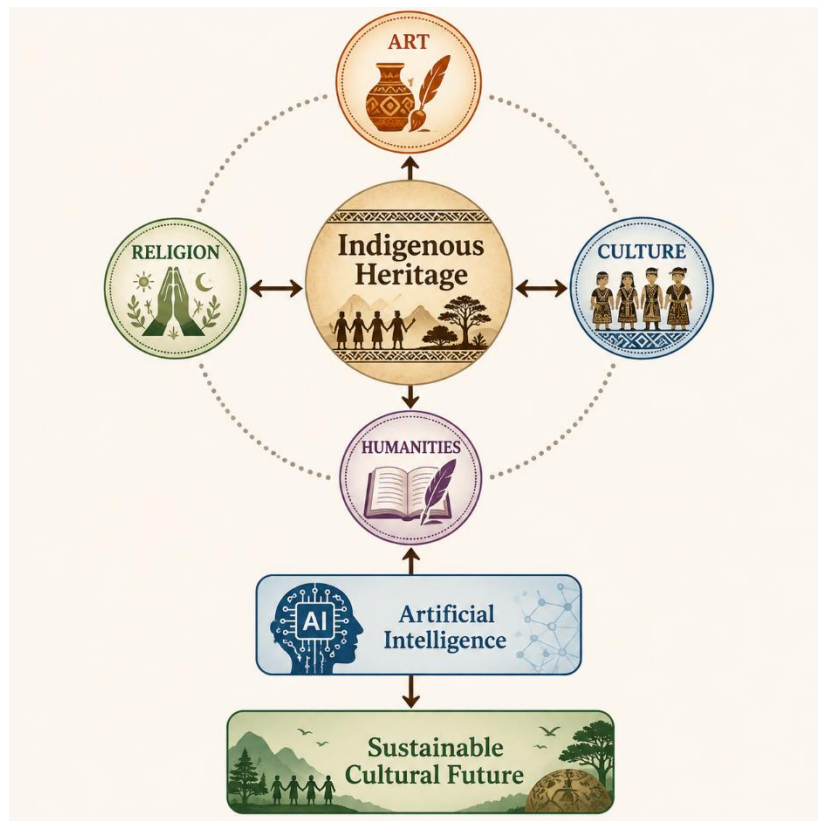


Figure 7. Integration of Art, Religion, Culture, Humanities, and Artificial Intelligence within Indigenous Heritage Sustainability. Source: Developed by the authors.

6.3 Practical Implications

The findings provide practical implications for policymakers, educators, indigenous communities, cultural organizations, and technology developers.

- **Policymakers** should support indigenous language revitalization through digital infrastructure, funding, and community-led governance.
- **Educational institutions** can integrate AI-assisted learning with cultural knowledge transmission.

- **Indigenous communities** may utilize digital technologies to preserve oral histories and strengthen intergenerational communication.
- **Technology developers** should prioritize ethical AI design, community participation, and Indigenous Data Sovereignty.

Effective implementation requires collaboration among indigenous communities, governments, researchers, and technology providers.

6.4 Policy Recommendations

Based on the findings of this study, five key policy recommendations are proposed to support the sustainable development of Indigenous language revitalization through AI and digital technologies. First, it is essential to establish National Indigenous Language AI Resource Centers that can support the development of language corpora, speech databases, and related AI research initiatives. Such centers would provide critical infrastructure for long-term language preservation and technological innovation. Second, promoting community-based digital heritage projects is vital, as these initiatives empower Indigenous communities to take the lead in documenting, preserving, and transmitting their own cultural knowledge.

In addition, strengthening Indigenous Data Sovereignty regulations is necessary to ensure that appropriate legal frameworks are in place to protect Indigenous ownership and control over linguistic and cultural data. Another important recommendation is the development of AI-assisted Indigenous education platforms, which should integrate advanced language learning technologies with Indigenous cultural values and knowledge systems to create meaningful and contextually relevant learning experiences. Finally, encouraging international collaboration can foster partnerships among Indigenous communities, academic institutions, and cultural organizations, thereby facilitating knowledge exchange, capacity building, and technological innovation across different regions. Together, these policy directions provide a comprehensive pathway for supporting Indigenous language sustainability in the digital age.

6.5 Final Reflection

The future of indigenous heritage preservation will not be determined solely by technological advancement. Rather, it depends upon communities' ability to maintain meaningful relationships with their languages, knowledge systems, cultural traditions, and future generations.

Artificial intelligence is a powerful tool, but cultural sustainability remains fundamentally a human endeavor. When guided by ethical governance, community participation, and respect for indigenous self-determination, AI can become a bridge connecting ancestral wisdom with future generations.

The transition from language preservation to cultural revitalization therefore represents not merely a technological transformation but a new approach to safeguarding cultural diversity and human heritage in the twenty-first century.

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References

- Assmann, Jan. 2011. *Cultural Memory and Early Civilization: Writing, Remembrance, and Political Imagination*. Cambridge: Cambridge University Press.
- Battiste, Marie. 2013. *Decolonizing Education: Nourishing the Learning Spirit*. Saskatoon: Purich Publishing.
- Berry, David M. 2012. *Understanding Digital Humanities*. New York: Palgrave Macmillan.
- Bird, Steven. 2020. "Decolonising Speech and Language Technology." In *Proceedings of COLING 2020*, 3504–3519.
- Blust, Robert. 2013. *The Austronesian Languages*. Canberra: Asia-Pacific Linguistics.
- Bostrom, Nick. 2014. *Superintelligence: Paths, Dangers, Strategies*. Oxford: Oxford University Press.
- Brynjolfsson, Erik, and Andrew McAfee. 2014. *The Second Machine Age*. New York: W.W. Norton.

Carroll, Stephanie Russo, Ibrahim Garba, Oscar Figueroa-Rodríguez, Jarita Holbrook, Raymond Lovett, Simeon Materechera, Mark Parsons, et al. 2020. “The CARE Principles for Indigenous Data Governance.” *Data Science Journal* 19 (1): 43–55.

Chiung, Wi-vun Taiffalo. 2001. *Language Attitudes toward Taiwanese and Indigenous Languages*. Taipei: Crane Publishing.

Council of Indigenous Peoples. 2024. *Indigenous Language Development Report*. Taipei: Executive Yuan.

Crystal, David. 2000. *Language Death*. Cambridge: Cambridge University Press.

Duxbury, Nancy, Jordi Pascual, and Jon Hawkes. 2017. “Why Must Culture Be at the Heart of Sustainable Urban Development?” *Agenda 21 for Culture Report*.

Fishman, Joshua A. 1991. *Reversing Language Shift: Theoretical and Empirical Foundations of Assistance to Threatened Languages*. Clevedon: Multilingual Matters.

———. 2001. *Can Threatened Languages Be Saved? Reversing Language Shift Revisited*. Clevedon: Multilingual Matters.

Floridi, Luciano. 2014. *The Fourth Revolution: How the Infosphere Is Reshaping Human Reality*. Oxford: Oxford University Press.

Floridi, Luciano, et al. 2018. “AI4People—An Ethical Framework for a Good AI Society.” *Minds and Machines* 28 (4): 689–707.

Frawley, William, Kenneth C. Hill, and Pamela Munro. 2002. *Making Dictionaries: Preserving Indigenous Languages of the Americas*. Berkeley: University of California Press.

Grenoble, Lenore A., and Lindsay J. Whaley. 2006. *Saving Languages: An Introduction to Language Revitalization*. Cambridge: Cambridge University Press.

Harrison, K. David. 2007. *When Languages Die: The Extinction of the World’s Languages and the Erosion of Human Knowledge*. Oxford: Oxford University Press.

Hawkes, Jon. 2001. *The Fourth Pillar of Sustainability: Culture’s Essential Role in Public Planning*. Melbourne: Common Ground Publishing.

Hinton, Leanne. 2011. *Bringing Our Languages Home: Language Revitalization for Families*. Berkeley: Heyday Books.

Hinton, Leanne, Leena Huss, and Gerald Roche, eds. 2018. *The Routledge Handbook of Language Revitalization*. New York: Routledge.

- Huang, Ying-kuei. 2017. *Taiwan Indigenous Peoples: Historical and Cultural Perspectives*. Taipei: Linking Publishing.
- Kaplan, Andreas, and Michael Haenlein. 2019. “Siri, Siri, in My Hand: Who’s the Fairest in the Land?” *Business Horizons* 62 (1): 15–25.
- Kukutai, Tahu, and John Taylor, eds. 2016. *Indigenous Data Sovereignty: Toward an Agenda*. Canberra: Australian National University Press.
- Lewis, M. Paul, Gary F. Simons, and Charles D. Fennig, eds. 2016. *Ethnologue: Languages of the World*. Dallas: SIL International.
- Li, Paul Jen-kuei. 2008. *Selected Papers on Formosan Languages*. Taipei: Academia Sinica.
- . 2015. *The Internal Relationships of Formosan Languages*. Taipei: Academia Sinica.
- Mager, Manuel, Arturo Oncevay, Katharina Kann, Thamme Gowda, and Alexis Palmer. 2021. “Findings of the AmericasNLP Shared Task on Open Machine Translation for Indigenous Languages.” In *Proceedings of ACL-IJCNLP 2021*, 202–217.
- McCarty, Teresa L., and Sheilah E. Nicholas. 2014. “Reclaiming Indigenous Languages: A Reconsideration of the Roles and Responsibilities of Schools.” *Review of Research in Education* 38 (1): 106–136.
- Nakata, Martin. 2007. *Disciplining the Savages, Savaging the Disciplines*. Canberra: Aboriginal Studies Press.
- National Academy for Educational Research. 2023. *Taiwan Indigenous Language Education Annual Report*. Taipei: NAER.
- Nicholas, Sheilah E. 2019. “Indigenous Language Education and Language Sustainability.” *Oxford Research Encyclopedia of Education*.
- OECD. 2021. *The OECD AI Principles*. Paris: OECD Publishing.
- Parsons, Mark, and Stephanie Russo Carroll. 2020. “Indigenous Data Governance.” *Data Science Journal* 19 (1): 31–42.
- Radford, Alec, Jong Wook Kim, Tao Xu, Greg Brockman, Ilya Sutskever, and Sandhini Agarwal. 2023. “Robust Speech Recognition via Large-Scale Weak Supervision.” OpenAI Technical Report.

- Rehg, Kenneth L., and Lyle Campbell, eds. 2018. *The Oxford Handbook of Endangered Languages*. Oxford: Oxford University Press.
- Roche, Gerald. 2019. *The Politics of Language Oppression in Tibet*. Lanham: Lexington Books.
- Russell, Stuart, and Peter Norvig. 2021. *Artificial Intelligence: A Modern Approach*. 4th ed. Hoboken, NJ: Pearson.
- Sahlins, Marshall. 1999. *Two or Three Things That I Know About Culture*. Chicago: University of Chicago Press.
- Simons, Gary F., and M. Paul Lewis. 2013. "The World's Languages in Crisis." *Language Documentation and Conservation* 7: 1–15.
- Smith, Laurajane. 2006. *Uses of Heritage*. London: Routledge.
- Smith, Linda Tuhiwai. 2021. *Decolonizing Methodologies: Research and Indigenous Peoples*. 3rd ed. London: Zed Books.
- Soini, Katriina, and Joost Dessein. 2016. "Culture-Sustainability Relation: Towards a Conceptual Framework." *Sustainability* 8 (2): 167.
- Spolsky, Bernard. 2009. *Language Management*. Cambridge: Cambridge University Press.
- Sung, Li-May. 2020. "Indigenous Language Revitalization in Taiwan." *Journal of Taiwan Indigenous Studies* 10 (2): 1–28.
- Svensson, Patrik. 2016. *Big Digital Humanities: Imagining a Meeting Place for the Humanities and the Digital*. Ann Arbor: University of Michigan Press.
- Taylor, Diana. 2003. *The Archive and the Repertoire: Performing Cultural Memory in the Americas*. Durham, NC: Duke University Press.
- Tegmark, Max. 2017. *Life 3.0: Being Human in the Age of Artificial Intelligence*. New York: Knopf.
- UNESCO. 2003. *Convention for the Safeguarding of the Intangible Cultural Heritage*. Paris: UNESCO.
- . 2011. *Atlas of the World's Languages in Danger*. Paris: UNESCO.
- . 2021a. *World Report: Re|Shaping Policies for Creativity*. Paris: UNESCO.

———. 2021b. *Recommendation on the Ethics of Artificial Intelligence*. Paris: UNESCO.

———. 2023. *World Report on Cultural Policies and Sustainable Development*. Paris: UNESCO.

United Nations. 2015. *Transforming Our World: The 2030 Agenda for Sustainable Development*. New York: United Nations.

United Nations Permanent Forum on Indigenous Issues. 2022. *State of the World's Indigenous Peoples*. New York: United Nations.

Wilson, Shawn. 2008. *Research Is Ceremony: Indigenous Research Methods*. Black Point, NS: Fernwood Publishing.

Wurm, Stephen A. 2001. *Atlas of the World's Languages in Danger of Disappearing*. Paris: UNESCO Publishing.