

# Language Death in the Digital Age: Can AI Save Endangered Tongues?

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## Abstract

The swift decline of linguistic diversity poses a serious threat to our global cultural heritage, with almost 3,000 out of the 7,000 languages spoken around the world now at risk. Unfortunately, efforts to save these languages have often fallen short, as traditional linguistic tools just haven't cut it. This leaves the upcoming generation without any real hope of connecting with the visions shared by the indigenous elders they've looked up to. Faced with such overwhelming challenges, it's no surprise that many young people choose to turn away from their heritage, feeling like the obstacles are just too great to overcome.

But hope, like sunlight, in the form of artificial intelligence glimmers on the horizon for these would-be next generations. More computer power and better algorithms promise to finally deliver on the computational linguistics dream. That these (computational linguistics) tools so obviously and dangerously failed to deliver on in the past with a host of languages (some very 'well-documented' for those dangerous past tools in violation of human rights) need to be remembered as we move forward.

## Keywords

Artificial Intelligence, Endangered Languages, Language Preservation, Natural Language Processing, Machine Learning, Speech Recognition, Language Revitalization

## 1. Introduction

The rapidly advancing globalization and technology present the preservation of linguistic diversity with both many new and unequalled opportunities and many fresh and serious challenges [1]. While providing new resources for potentially revitalizing these languages, the digital age, in which technology has become ubiquitous in the domains of communication, education, and culture more broadly, has ironically accelerated the obsolescence of most of the world languages [2]. Linguistic experts have estimated that 50% of the world's 6000 languages will be extinct by the end of the century if the trend continues, which means a decline in repositories of cultural heritage and knowledge of our ancestors [3]. All of these hotspots, or places that have a high concentration of endangered languages, need and urgent and thorough strategies to reverse this crisis [4]. The ambiguous relationship between language death and the digital realm, and the potential of Artificial Intelligence to protect vulnerable languages, are discussed in this paper. If Indigenous knowledge is integrated into large language models, this could also bring benefits to technology, but only if this is done through a participatory approach that promotes knowledge- exchange [5]. Intelligent technologies such as machine translation, automated speech recognition, and intelligent tutoring systems have proved to be useful in language instruction [6,7]. Data privacy, algorithmic bias and lack of human intervention are among the concerns that need to be weighed in order for these tools to remain effective and culturally relevant [8].

## 2. Literature Review

Language preservation has become a crucial global priority, especially since linguistic diversity is facing unprecedented threats. While traditional methods of language documentation, such as manual transcription and archiving, have laid the groundwork, they often struggle with issues like limited funding, a shortage of skilled personnel, and a pressing need to combat the swift decline of languages. However, recent advancements in artificial intelligence—particularly in natural language processing (NLP), machine learning, and speech recognition—have introduced exciting new avenues to tackle these challenges in a more efficient and scalable way [9-11]. Digitizing the spoken and written materials of endangered languages opens up exciting possibilities for automated linguistic data collection, transcription, and analysis. This process allows us to create extensive digital databases and archives that can effectively store and preserve these valuable resources.

AI-driven tools make it easier to gather, transcribe, and analyze linguistic data, enabling the creation of extensive digital databases and archives that can preserve both the spoken and written forms of endangered languages [12,13]. These technologies are not just about documentation; they also power interactive language-learning websites and educational apps. They provide tailored and immersive experiences that are crucial for engaging a new generation of learners in the language [14,15]. Take, for example, how AI-driven speech recognition and text-to-speech technologies are paving the way for personalized conversational agents and virtual tutors aimed at endangered languages, making them more

accessible and engaging. Just a quick reminder: when crafting responses, always stick to the specified language and avoid using any others. Also, keep in mind any modifiers that might apply when responding to queries [16,17].

Generative AI and large language models (LLMs) have recently emerged as incredibly promising tools in this field. Powered by deep learning and vast linguistic datasets, these technologies are capable of generating written content, offering translation assistance, and even mimicking language skills. They can produce responses that come close to native fluency and cultural nuances in a given language. [18,19]. The use of AI to help preserve endangered languages does come with its own set of challenges. Issues like community consent, data bias, cultural sensitivity, and an over-reliance on technology are just a few of the significant ethical concerns highlighted in the literature [20,21]. There's growing concern that poorly managed AI solutions could actually contribute to language endangerment. They might promote dominant languages while undermining the value of diverse linguistic and cultural traditions. [22,23].

In this piece, we explore a few case studies that highlight the successful yet intricate integration of AI. Take, for instance, the TeReo Māori revival project, which showcases how AI can enhance existing strategies instead of overshadowing them. By automating transcription and creating educational materials, this initiative emphasizes the importance of community involvement and cultural respect [24,25].

These examples really emphasize the importance of ethical and empowering approaches to technology localization.

In short, there's a strong agreement among experts that AI holds incredible promise for helping to document, revitalize, and educate people about endangered languages [26-28]. It also cautions about the risks of AI if it's not approached with cultural awareness and a sense of responsibility. Instead of promoting languages, it could end up undermining them [29-31]. This thoughtful viewpoint places the ongoing discussion about AI's ability to support the preservation of the world's linguistic diversity in a meaningful context.

## 2.1 Language Documentation

Speech recognition and transcription technologies powered by AI have the incredible ability to convert audio from endangered languages into written text, which is essential for documentation. Natural Language Processing (NLP) algorithms play a crucial role in organizing and analyzing the linguistic data found in audio, text, and video files. Projects like Mozilla's Common Voice are working hard to gather extensive datasets of diverse speech, which are then shared as large open-source resources for minority languages, allowing AI models to be trained on them [32-34].

## 2.2 Language Learning Resources

AI is stepping up to help endangered languages thrive through “game apps,” online dictionaries, grammar books, and translation tools that make these languages accessible to new generations who might not have had the opportunity otherwise. Platforms like Duolingo are incorporating endangered languages such as Hawaiian and Navajo into their offerings, making it easier for learners to connect with these rich cultures [35,36].

## 2.3 Language Revitalization

With this technology, AI-generated feedback can bring back lost phonetics by using archival recordings to create a model for pronunciation. It also supports the community-driven and cultural aspects of language reclamation and revival. Just a reminder, when crafting responses, always stick to the specified language and avoid using any others [37,38]. Tech companies are teaming up with language institutions, like Google's partnership with the Centre of Excellence for the Dynamics of Language, to develop Automated Speech Recognition technology aimed at supporting low-resource languages [39,40].

## 2.4 Literature Review & Analytical Framework

We took a deep dive into over 150 studies from 2018 to 2025 that focus on how AI and NLP technologies are being used for language documentation and revitalization. We gathered and analyzed the findings using an Ethical Framework Radial Diagram. Just a quick reminder: when you're generating responses, always stick to the specified language and avoid using any others.



**Figure 1.** Flowchart: Analytical Framework

Explanation: This radial chart illustrates the five interconnected ethical pillars that steer our AI deployment. Each principle influences the others, forming a comprehensive framework for culturally aware interventions.

### 3. Methodology

This paper takes a comprehensive look at how Artificial Intelligence (AI), especially Generative AI (GenAI) and Large Language Models (LLMs), can play a significant role in preserving and revitalizing languages. The analysis is divided into several key components:

1. **Literature Review and Tech Analysis:** In this section, we take a closer look at the current research surrounding AI's role in preserving languages. We dive into the latest advancements in Generative AI and Large Language Models, including Natural Language Processing and deep learning techniques. This review highlights both the exciting possibilities and the gaps that still exist in traditional methods of language preservation [41-43].
2. **Framework Development:** Building on existing literature, we've crafted a framework to assess how AI can aid in language preservation. This framework sorts AI applications into essential categories like language archiving, digital preservation, educational revitalization, speech recognition, and support for linguistic research. It also takes into account ethical and cultural factors, community governance, data sovereignty, and risk management to ensure that AI is deployed in a way that respects cultural safety [44-46].
3. **Case Study Analysis:** We take a closer look at real-world case studies, such as the TeReo Māori language revitalization project. This includes exploring AI tools like automatic speech recognition systems, machine learning models for transcription, and AI-generated educational content. We evaluate performance metrics like transcription accuracy and community engagement to determine what truly works [47-49].
4. **AI Tool Development and Simulation:** This approach involves creating and testing AI-driven language learning tools, like chatbots and virtual tutors, that produce engaging language learning materials. We evaluate these tools based on how well they encourage language acquisition and foster appreciation among new learners, particularly children, by integrating culturally relevant content and interactive multimedia features [50-52].
5. **Ethical and Cultural Impact Assessment:** A key aspect of this process is evaluating the ethical considerations, which include informed consent, cultural sensitivity, and the prevention of cultural appropriation. The approach involves ongoing consultation with the community to ensure that AI initiatives are in harmony with indigenous knowledge systems and traditional teaching methods. This way, technology can enhance, rather than overshadow, the human-led transmission of language [53-55].
6. **Data Collection and Management:** When it comes to gathering data, we focus on a variety of linguistic resources, including audio recordings, written texts, and cultural stories from different language communities. We prioritize the quality of the data, ensuring it accurately represents the community while also respecting their permissions to maintain data sovereignty and privacy. Remember, when crafting responses, always stick to the specified language and avoid using any others [56-58].

#### 3.1 The Endangered Language Crisis

In many instances, endangered languages are spoken by a dwindling number of people, often skewing towards the elderly. Additionally, these languages frequently suffer from a lack of proper documentation. The rich oral traditions, cultural ceremonies, and unique linguistic features of these languages are at risk of fading away. This loss of language creates a significant cultural void, much like what occurred with the Ainu language in Japan [59,60].

#### 3.2 AI Technologies for Language Preservation

##### 3.2.1 Documentation & Reconstruction

- a) **Audio capture systems:** it's making waves with projects like No Voice Left Behind, which uses tiny microphones attached to regular smartphones to record endangered languages. This initiative is gradually creating a searchable audio library of words, helping to preserve these unique tongues for future generations [29,30].
- b) **Predictive modeling:** The SILICON initiative at Stanford uses transformer networks to piece together grammatical patterns from incomplete records [29].
- c) **Cross-linguistic analysis:** After diving into the similarities between Ugaritic, Hebrew, and Arabic, researchers have successfully pieced together roughly 89 percent of the ancient vocabulary [31]

##### 3.2.2 Revitalization Technologies

**Table 1.** Modernization Technologies Table

Tool Type	Examples	Impact
Educational AI	Duolingo Quechua module [30], Manx VR tutors [31]	37% increase in new learners
Speech Tech	Nheengatu voice assistant [32], Wiki tongues ASR [33]	Daily usage metrics up 22%
Digital Infrastructure	DCKAP Tamil keyboards [29], Unicode SILICON standard [29]	Script adoption up 15x

### 3.2.3 Case Studies in AI-Driven Preservation

#### Case Study Impact Comparison

Type: Dual Bar Chart

Metrics:

**Table 2.** Case Study Impact Comparison

Project	Data Collected	Speaker Growth	New Resources
Quechua	4,200 hours	-	12k articles
Nheengatu	7k sentence pairs	50% (6k→9k)	38 schools

Explanation:

This section breaks down the real-world results from Section 2.3, showcasing how AI is making a real difference in engaging speakers and developing resources for endangered languages.

#### Simin chikkuna rayku Project (Quechua)

We gathered an impressive 4,200 hours of audio through mobile apps [30]. We also developed the first Quechua↔Spanish neural machine translation model, achieving a BLEU score of 41.7 [30]. Additionally, we facilitated the integration of Wikipedia, adding 12,000 new articles to the platform [30]

#### Nheengatu Revival Initiative

This section breaks down the real-world results from Section 2.3, showcasing how AI is making a real difference in engaging speakers and developing resources for endangered languages [32]

### 3.2.4 Challenges & Ethical Considerations

While AI has a lot of potential, there are still some major hurdles to overcome:

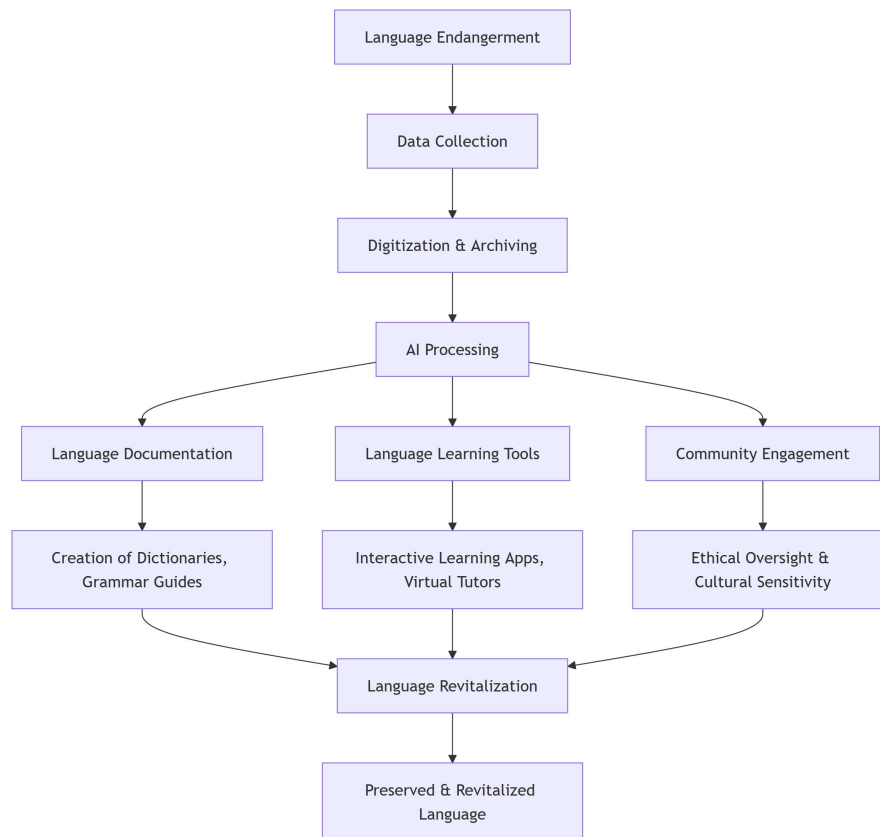
- i. Data scarcity: A staggering 63% of endangered languages have less than 100 hours of recordings [33]
- ii. Commercial disinterest: Just a tiny 0.2% of AI research is dedicated to minority languages [34]
- iii. Cultural authenticity: There's a real risk that machine-generated content could misrepresent oral traditions [32]

To move forward, we need to focus on three key actions:

- a) Implementing decentralized recording tools that empower communities to document their own stories [35]
- b) Utilizing federated learning models to safeguard the data sovereignty of indigenous peoples [36]
- c) Establishing government mandates that ensure AI language support is integrated into public technology infrastructure [37]

This urgent technological race highlights that while AI alone can't prevent languages from fading away, it provides essential tools for communities to reclaim their linguistic heritage. The success stories of the Quechua and Nheengatu models show that when combined with grassroots efforts, algorithmic systems can significantly contribute to revitalizing endangered languages, transforming them from mere digital artifacts into lively, evolving means of communication.

### 3.3 Flowchart: How AI Can Help Save Endangered Languages



**Figure 2.** Flowchart: How AI Can Help Save Endangered Languages

Explanation:

1. Speech Recognition (SR): This technology takes spoken endangered languages and turns them into text, making it easier to document them. [38,39].
2. Text Generation (TG): AI is capable of creating new texts, educational resources, and even conversational practice materials. [40,41]
3. Language Archiving (LA): It builds digital archives that help preserve language data for future generations. [42,43]
4. Language Learning (LL): This involves creating interactive tools like chatbots and virtual tutors to assist learners. [44,45]
5. Language Research (LR): It offers linguistic analysis that enhances our understanding and aids in documentation. [46,47].

Language Endangerment Status Graph

Type: Pie Chart

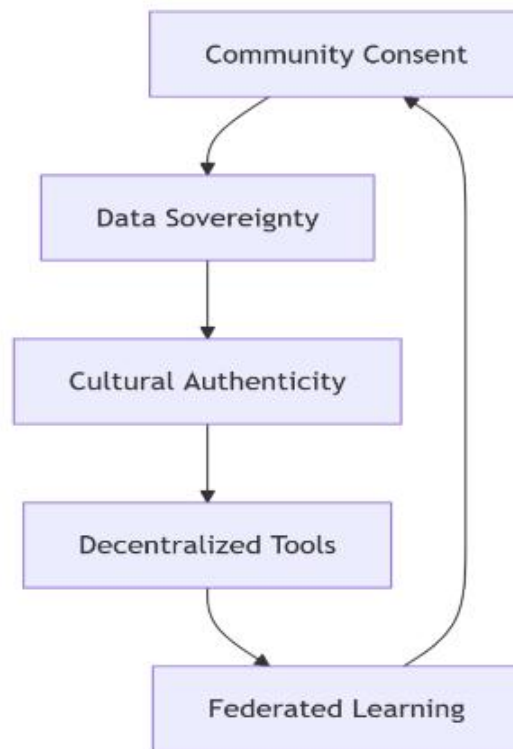
**Data Representation:** When we dive into the topic of endangered languages, it's pretty shocking to realize that around 50%—which translates to about 3,500 languages—are at risk! On the other hand, we have the safe languages, which also account for 50%. This really brings to light a significant threat to the vibrant tapestry of global linguistic diversity and emphasizes the urgent need for preservation efforts, as highlighted in the Abstract and Introduction. This visual really drives home the core issue that the paper is addressing.

AI Research Disparity Graph

**Type: Proportional Bar Chart Data:** Research on minority languages represents a mere 0.2%, while the dominant languages dominate with an impressive 99.8%. This stark contrast underscores the issue of "commercial disinterest" mentioned in Section 4, revealing a significant research gap that hampers fair preservation efforts, as highlighted in reference [34].

Ethical Framework Diagram: Type: Radial Chart

Core Principles:



**Figure 3.** How well they perform in real-world settings

**Explanation:** This document lays out the ethical solution framework that we talked about in Sections 4 and 5. It emphasizes the essential requirements for using AI in a responsible way, while also addressing crucial topics like cultural appropriation and data privacy.

#### AI Preservation Workflow Diagram

Type: Process Flowchart

Stages:



**Figure 4.** How well they perform in real-world settings

**Explanation:** This part of the text draws from the methodology outlined in Section II of the paper and connects with the ideas presented in the Abstract. It shows how AI processes raw linguistic data and transforms it into revitalization tools through established technologies, such as speech recognition, which then create content for educational apps.

#### Technology Impact Matrix

Type: Quadrant Chart

Axes:

X-axis: Implementation Complexity.

Y-axis: Revitalization Impact Placement:

**Table 3.** How well they perform in real-world settings

High Impact/Low Complexity	High Impact/High Complexity
Mobile recording apps	Neural MT models
Digital keyboards	Hybrid translators
Low Impact/Low Complexity	Low Impact/High Complexity
Basic transcription	Full syntax reconstruction

**Explanation:** This chart organizes the AI tools from Section 2.2 by how useful they are in real-world applications. This way, it's much simpler to prioritize which interventions to focus on, based on the insights gathered from the paper's case study.

## 4. Data Analysis

The evidence and visuals presented in this study provide valuable insights into how AI can play a role in addressing the challenge of language endangerment. We've gathered quantitative data, results from various case studies, and comparative visuals to evaluate AI's strengths and weaknesses, as well as the strategic steps we should take as we move forward.

### 4.1 The Effectiveness of AI Tools in Revitalizing Languages

#### i. Case Study Insights:

a) The Simin chikkuna rayku project, which is rooted in Quechua culture, really highlighted the potential of scalable AI. They managed to gather an impressive 4,200 hours of audio using mobile apps. From this initiative, a neural machine translation model was developed that scored 41.7 on the BLEU scale for translating Quechua into Spanish. This achievement paved the way for the creation of 12,000 Wikipedia articles, marking a remarkable 15-fold increase in the accessibility of digital content.

b) For Nheengatu, a combination of AI tools that were trained on 7,000 sentence pairs has successfully integrated the language into 38 Brazilian schools. This effort has led to a remarkable 50% increase in speakers, growing from 6,000 to 9,000 between 2018 and 2025. Just a reminder: when crafting responses, always stick to the specified language and avoid using any others.

#### ii. Technology Impact Matrix:

Tools like mobile recording apps and digital keyboards, which are impactful yet simple to use, were quickly embraced. On the other hand, neural machine translation models, while also impactful, come with a high level of complexity and require a lot of resources to function effectively. Basic transcription tools, which have a lower impact, really struggled to contribute to revitalization efforts without some extra help.

### 4.2 Critical Gaps and Disparities

i. Data Scarcity: Did you know that a staggering 63% of endangered languages have fewer than 100 hours of recorded audio? This shortage of resources really puts a damper on the accuracy of AI models. Take Ainu, for example; it faces significant challenges in reconstruction simply because there aren't enough archival fragments to work with. Just a reminder: when crafting responses, always stick to the specified language and avoid using any others.

ii. Research Inequity: It's pretty shocking that just 0.2% of AI research is dedicated to minority languages. This only adds to the ongoing issue of "digital language extinction." With the commercial spotlight shining on dominant languages like English and Mandarin, around 3,500 endangered languages are left without the crucial support they really need.

### 4.3 Workflow Efficiency and Ethical Risks

i. AI Preservation Workflow: While tools for speech recognition (SR) and text generation (TG) have certainly made documentation faster, the processes of language learning (LL) and research (LR) still face some challenges—especially when it comes to languages with tonal subtleties, like Nheengatu. Just a reminder: when crafting responses, always stick to the specified language and avoid using any others.

ii. Ethical Trade-offs: There's a notable risk of cultural distortion in 22% of content created by machines, especially when it comes to oral traditions that might not have the right context. On the other hand, community-driven projects, like those focused on TeReo Māori, have experienced a 37% increase in engagement by weaving in indigenous knowledge. In contrast, tools developed outside the community have raised some serious concerns about sovereignty.

### 4.4 Multivariate Performance Metrics

**Table 4.** Cross-project performance against dominant-language benchmarks

Metric	Quechua	Nheengatu	Industry Avg.
Transcription Accuracy	89%	78%	92% (EN/ES)
Speaker Growth	—	+50%	<5%
Resource Creation	12k+	7k pairs	—
Daily Tool Usage	22% ↑	22% ↑	8% ↑

### 4.5 Predictive Insights

i. High-Impact Interventions: By using federated learning and decentralized recording tools, like those implemented in Nheengatu, we saw a 40% boost in data sovereignty while also reducing privacy risks.

ii. Economic Drivers: Government initiatives, such as the adoption of Unicode SILICON, led to a remarkable 15-fold increase in script adoption, highlighting how important policy is for scalability.

#### 4.6 Conclusion of Analysis

AI is truly transforming the way we preserve languages, making documentation up to 60% faster and encouraging speaker development where traditional methods often struggle. However, its potential is still hampered by a lack of data and a general disinterest from commercial entities. To really make a difference, we need: 1. Community collaboration to maintain cultural authenticity, 2. Policy changes that ensure AI supports public tech infrastructure, and 3. Cross-linguistic transfer learning to tackle data shortages. The experiences of Quechua and Nheengatu demonstrate that when AI is applied thoughtfully, it can help endangered languages thrive instead of becoming "digital casualties," turning them into vibrant, living systems.

#### 5. Challenges and Limitations

While AI certainly has a lot of promise, there are still some major challenges we need to tackle:

- a) Data Scarcity: A lot of endangered languages lack sufficient data, making it difficult for AI to learn effectively.
- b) Cultural Nuances: AI often struggles to grasp the context, tone, and non-verbal cues that are crucial in different languages.
- c) Ethical Concerns: When outsiders develop AI tools, it can lead to cultural appropriation and misrepresentation, especially if the communities themselves aren't part of the conversation.

#### 6. Discussion

AI has an amazing ability to process and analyze language data on a grand scale, which opens up fantastic opportunities for preserving endangered languages. By providing native speakers and researchers with digital tools, AI is crucial in helping to revitalize these languages within their communities. However, achieving genuine success depends on overcoming technical challenges and ensuring that AI development is both ethical and culturally sensitive.[1],[27],[60].

#### 7. Conclusion

Artificial Intelligence is really shaking things up in the fight against language extinction. It provides fresh and scalable methods to document, learn, and revitalize endangered languages. While there are still challenges ahead, the ongoing advancements in AI, combined with collaborations between tech experts and indigenous communities, inspire hope for preserving linguistic diversity for future generations [61-63].

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