


Artificial Intelligence for the Preservation of Native Languages: The Case of Quechua in Peru¹

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Abstract. The purpose of this research is to understand the challenges, opportunities, and implications associated with the design and use of Artificial Intelligence (AI) tools to preserve the native Quechua language in Peru. We conducted a theoretical analysis regarding how AI could be applied to protecting Quechua. We also interviewed two Quechua speakers, an expert in the Quechua language, and two experts in language localization and translation. The conclusion was that Quechua is essential to Peruvian identity; however, its preservation faces significant challenges. Although there are laws and government projects to promote it through technology, these have proven ineffective due to a lack of participation from native speakers and engaging content. Therefore, the inclusion of Quechua in AI tools becomes crucial for its intergenerational transmission and for non-speakers to learn the language. However, this requires overcoming the digital divide and the scarcity of linguistic resources. Furthermore, the creation of these tools must guarantee the active participation of communities, protect data sovereignty, and respect cultural diversity. Moreover, AI does not replace social interaction or public policies, so collaborative strategies are needed between the government, the private sector, and organizations that advocate for linguistic rights. Ultimately, success is not measured by the number of applications created, but by their capacity to empower communities and strengthen the everyday use of the language.

Keywords. linguistic revitalization, emerging technologies, cultural diversity, intercultural education, digital decolonization.

La inteligencia artificial para la conservación de lenguas originarias: el caso del quechua en Perú

Resumen. El propósito de esta investigación es comprender los retos, desafíos, oportunidades e implicancias asociados al diseño y uso de herramientas de Inteligencia Artificial (IA) para preservar la lengua originaria quechua en Perú. Para ello, se efectuó un análisis teórico respecto a cómo la IA podría ser aplicada para la preservación del quechua. Asimismo, se elaboró una serie de entrevistas a dos personas quechuas hablantes, un experto en la lengua quechua y dos expertos en el área de la localización y traducción de idiomas. La conclusión fue que el quechua es esencial para la identidad peruana; sin embargo, su preservación enfrenta retos significativos. Aunque existen leyes y proyectos estatales para difundirlo mediante tecnologías, estos resultan poco efectivos porque carecen de la participación de hablantes y de contenidos atractivos. Por ello, la inclusión del quechua en herramientas de IA se vuelve clave para su transmisión intergeneracional y el aprendizaje de no hablantes. No obstante, esto requiere superar la brecha digital y la escasez de recursos lingüísticos. Asimismo, la creación de estas herramientas debe garantizar la participación activa de las comunidades, proteger la soberanía de los datos y respetar la diversidad cultural. Además, la IA no sustituye la interacción social ni las políticas públicas, por lo que se necesitan estrategias colaborativas entre Estado,

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sector privado y organizaciones defensoras de derechos lingüísticos. En definitiva, el éxito no se mide por aplicaciones creadas, sino por su capacidad de empoderar comunidades y fortalecer el uso cotidiano.

Palabras clave: revitalización lingüística, tecnologías emergentes, diversidad cultural, educación intercultural, descolonización digital.

Summary: 1. Introduction. 1.2. Research problematization. 1.3. Context of the problem. 2. Research Methodology. 2.1. Data collection technique and instrument- 2.2. Procedure for collecting and evaluating information. 3. Results and discussion. 4. Conclusions. 5. Data availability. 6. Declaration of contribution by authorship.

1. Introduction

According to the National Institute of Statistics and Informatics of Peru (INEI), in Peruvian territory, people who have an indigenous language as their mother tongue represent more than 15% of the country's total population; thus, there are a total of 48 languages considered to be indigenous in the country (Quechua, Shipibo, Aimara, Awajún, etc.) (Cabanillas Vela 2022). And, in recent years, it has been specifically documented that the indigenous Quechua language of the South American region is in danger of becoming extinct (Pimentel 2021). Moreover, in 2010, through the document *Atlas of the World's Languages in Danger*, UNESCO categorized Quechua among the indigenous languages that were in danger of disappearing (Moseley & Nicolas 2010).

In the case of Peru, the situation of the possible extinction of this native language is alarming, considering that Quechua is spoken by about 3 million 375,682 citizens, which represents 13.9% of the total Peruvian population. And, even though experts have referred to it as a vital language, the varieties it has in different parts of Peru are in danger of extinction (Quechua of Ancash, Quechua of Huanuco, Quechua of Cajamarca, etc.), because there are generally no effective actions for its preservation (El Peruano 2021). This is aggravated by the fact that the people who speak this language are those who suffer the most from poverty and, therefore, may not have the resources that would allow them to benefit from language preservation actions (INEI 2017a).

The detailed circumstances regarding the danger of extinction of the native Quechua language need to be addressed since those who speak it are the indigenous populations and their descendants, who have the right to have their knowledge, history, languages, and writing schemes revitalized, used, disseminated, and spread from generation to generation. And, although the process of revitalizing their languages and cultures is not quick, it would be pertinent to promote actions of will and investment, and, above all, actions focused on the implementation of resources that help such preservation to pursue clear objectives (Choque Bustinza et al. 2021).

Additionally, in the case of indigenous languages, AI could help document them, making it possible to develop dictionaries and grammatical structures, or perhaps provide translation of documents. All this, of course, is complemented by public policies and coordinated projects that would serve to teach these languages, which could preserve cultural and linguistic variety (Cusilayme Barrantes et al. 2023). It should also be noted that the possible use of AI to preserve languages such as Quechua will depend, in the first place, on the Peruvian government. Support for the above is found in the American Declaration on the Rights of indigenous Peoples (2016), which states that there is an obligation on the part of States to recognize and respect the linguistic diversity of indigenous peoples. In addition, the document also states that indigenous peoples have the right to have their knowledge, traditions, and writings preserved, used, revitalized, and disseminated from generation to generation.

Likewise, if AI is used as an instrument to safeguard an indigenous language, it should be used in such a way that the ancestral knowledge of the indigenous communities is respected and valued. This means that the collection and use of information and traditional knowledge of indigenous peoples should be done with their approval, considering a perspective of preservation and defense of their language and culture (Mamani Yucra & Quispe Pacco 2022).

However, the fact of resorting to ICTs and emerging technologies to potentially preserve Quechua is because there have previously been non-computational projects to preserve this language, such as the Peruvian government's initiatives with an educational focus on the rural Quechua-speaking population. Nevertheless, such projects have had some shortcomings, such as a) failure to develop adequate materials in the Quechua language (due to the lack of inclusion of experts in translation and localization of languages and Quechua speakers), and b) projects that have not had defined objectives or clear policies that promote the inclusion of Quechua learning. In contrast, with computational technology initiatives, there has recently been a significant increase in projects that seek to teach such language through data collection and applying machine learning procedures with AI; which could be promising for the implementation of text translation systems or voice recognition systems, although all this is still very limited and has no further scope (Álvarez-Crespo et al. 2023).

Similarly, it should be noted that applying AI systems to preserve Quechua in Peru could represent a great challenge because the country still lags far behind in terms of technological infrastructure. Proof of this is that the government portal with open data for the population has only prospered in 55%, and half of the citizens do not have access to the Internet (Gomes et al. 2020, cited in Luna 2023). This would reflect that at the state level, it could be complex to develop digital projects that reach the largest number of Quechua speakers, constituting a challenge for the possible implementation of AI tools that preserve Quechua.

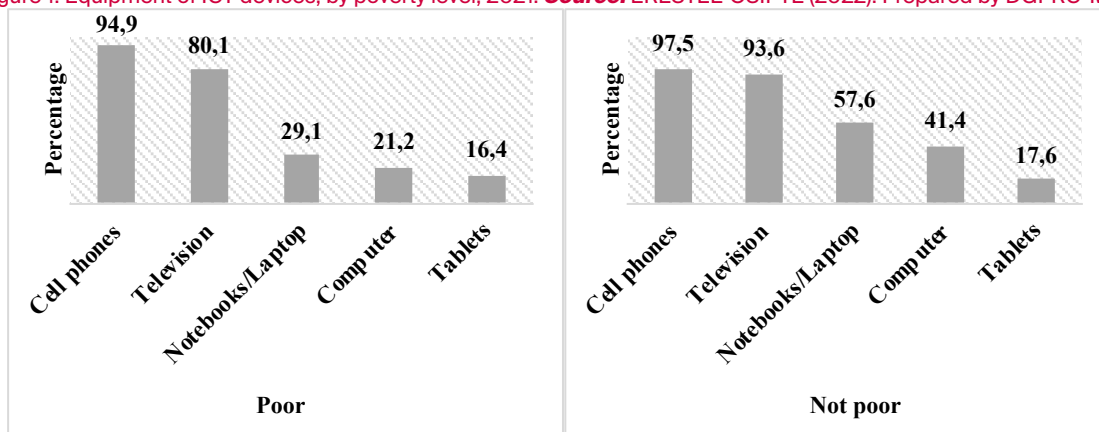
After the above, the following research question arises: What would be the challenges, opportunities, and implications associated with the development of AI tools to preserve the native Quechua language in Peru?

The objective of the research is to understand the challenges, opportunities, and implications associated with the design and use of AI tools to preserve the native Quechua language in Peru.

1.2. Research problematization

Peru is considered one of the most innovative countries in the Latin American region in AI regulation, with its National Artificial Intelligence Strategy (ENIA) 2021-2026, and its Law No. 31814 (which sets the conditions to ensure that AI is developed and used responsibly) (UNESCO 2024). Nevertheless, at the state level, due to the lack of technological infrastructure, which mostly affects Quechua speakers in poor areas (Casma, 2014), no solid initiatives have been developed that have AI as a tool for the preservation of Quechua or any other indigenous language. In addition to the above, according to INEI (2023), only 33% of households considered poor have internet access, compared to 61.4% of non-poor households. This is even though 94.9% of poor households in Peru have cell phones, while 97.5% of non-poor households have cell phones. On the other hand, of the households considered poor, 29.1% own a digital device (either a notebook or a laptop). Of the households considered as non-poor, 56.7% have such devices. In the case of computers, only 21.2% of households considered poor have a computer. Meanwhile, 41.4% of households considered non-poor have such a device (Ministry of Transportation and Communications 2023).

Figure 1. Equipment of ICT devices, by poverty level, 2021. **Source:** ERESTEL-OSIPTE (2022). Prepared by DGPRC-MTC.



These statistics are important, considering that the Quechua-speaking population is one located in the poorest areas, and therefore, the one that would have more limitations to access AI programs that require the Internet.

Therefore, it would be understood that to implement AI programs or projects in Peru that include the Quechua language, it would first be necessary to work on solving the deficiencies in technological infrastructure, which is essential if AI is to be used as an ally in the process of linguistic and cultural conservation (Cuadros Rojas 2023).

Why begin to see AI as a possible ally to preserve Quechua in Peru? Well, previously, the Quechua-speaking population has found many interactive ways to share information in their language through social networks. However, the population has reported that a constant difficulty is that this information is mostly in Spanish. Also, it has been found that not all the population has the digital skills to make constant use of these digital tools (Herrera Corahua 2022). Given this, AI could be a support, since, compared to other technological tools, with AI, people could communicate effectively just by talking to chatbots, facilitating the practice and dissemination of languages (British Council 2024).

On the other hand, the few procedures implemented to disseminate, revitalize, and recover native languages have not effectively contributed to the preservation of such languages. Likewise, a fraction of Peruvian society does not have a concrete motivation to disseminate and acquire knowledge of native languages and their oral tradition, and there are no areas in which such languages can be disseminated from generation to generation. Finally, there is no effective coordination between public and private agents to preserve languages such as Quechua (Bruno López et al. 2023).

Additionally, it can be said that, if the initiatives developed in the past to preserve Quechua failed, it was because they did not include the Quechua-speaking population, nor experts in translation or language localization for the proper development of materials in Quechua. This is very important, considering that the background of the use of AI in languages comes from the design of statistical machine translators. This situation gave rise to initiatives such as the Moses for localization (m4loc) project, whose goal was to adapt statistical machine translation to the needs of those working in the field of localization (Llerena García 2023), with the participation of experts to detect translation errors, and thus aim at optimizing localization, which is crucial in the case of translation of indigenous languages.

Yet, the participation of localizers and translators could also be important if AI systems are to be designed for the preservation of Quechua because AI is not yet able to understand in detail the circumstances, characteristics, and social contexts of all languages. This is even more important in the case of indigenous languages, where data are scarce, which could lead to errors or inaccuracies in sentence structure (Rukiati et al. 2023). And, this is precisely where localizers could potentially enter a revision procedure. In addition, another challenge of

this technology would be to include in its design the social, cultural, linguistic, or abilities aspects (Murrugarra Retamozo 2024a, 2024b) of the Quechua-speaking population (Murrugarra Retamozo 2023a); and here, again, the localizers could be of great help, as well as the population that speaks the language. Additionally, it should be noted that other AI tools may have deficiencies in pronunciation or in establishing a fluent conversation (Fakher Ajabshir 2023). This should be adapted according to the social, cultural, and linguistic context of the Quechua-speaking population.

1.3. Context of the problem

To have a more appropriate context of the problem, about the challenges, opportunities, and implications associated with the development of AI tools to preserve Quechua in Peru, according to the National Policy of Native Languages, Oral Tradition, and Interculturality to 2040, in Peru, four factors have made difficult the dissemination, revitalization, and rescue of native languages, including Quechua, which would be:

- Lack of incentives for both indigenous languages and their oral traditions to be disseminated and taught among the members of indigenous communities, those who acquired the languages as an inheritance, and all citizens in general.
- Limited competencies of the main agents to elaborate, administer, and guide the processes of preservation, revitalization, and linguistic rescue.
- Insufficient places for the intergenerational dissemination of indigenous languages and oral traditions.
- Lack of organization of state and private agents to preserve, revitalize, and rescue native languages.

It should also be noted that some specialists have previously documented through dialogues with representatives of indigenous peoples that Quechua could be considered one of the 26 vital languages; however, the concern about its vitality comes from the isolation in which many Quechua-speaking indigenous peoples live, which could endanger its survival. Factors that could endanger the language are related to the presence of land expropriators, oil companies, people who carry out illegal forestry activities, and more (Ministry of Education 2013).

Now, for a better precision of where and how many people speak Quechua in Peru, according to the latest INEI census (2017b), the ten districts with the highest number of people who speak Quechua are in the department of Lima. Being the district of San Juan de Lurigancho, the one with the highest number of people who use that language (represented by 10.83 % of the total Peruvian population). The district with the highest density of Quechua speakers is Chaca, with 98.77% of its citizens. Meanwhile, the province with the highest density of Quechua speakers is Mariscal Luzuriaga (92.02% of its population). Finally, the highest density of Quechua speakers per department is for Apurimac, with 69.69% of people who speak this language. However, it can be said that the increase or decrease in the number of Quechua speakers could change radically at any time, both in the departments, provinces, and districts (Andrade Ciudad, 2019). This would make it essential to develop concrete strategies and actions for the preservation of Quechua.

Thus, due to the importance of preserving a language such as Quechua, it would be appropriate that any action taken as a reference to the Global Action Plan of the International Decade of Indigenous Languages (UNESCO 2021), to which Peru is a party. This document establishes that to preserve indigenous languages, it is vitally important to include the participation of native populations through their representatives, as well as the participation of the public institutions that protect them in preservation actions. To achieve this, it would be important to empower indigenous populations to help preserve, support, and promote the use of their languages, which could be achieved through projects that develop their capabilities in the digital world. In this way, indigenous populations could benefit from the advantages that technologies, such as AI, offer them in the revitalization of their languages, cultures, and traditions.

Despite the above, it should be noted that at least from the public sector, i.e., the Peruvian government, no solid AI projects have been found to preserve Quechua that include the support of localization and translation experts, indigenous populations, and other Quechua speakers. However, some private initiatives are trying to address this issue. For example, AI tools such as Google Translate or the ChatGPT platform (which uses generative AI) have developed content with basic elements of Quechua in their systems. Nonetheless, the deficiency lies in the fact that these tools do not yet have fundamental elements of the linguistic syntax of the language. However, the novelty could be that, as in the case of English, an AI conversation simulator could be used to practice Quechua, which is expected to happen in the future (Mendoza Mori 2024). Therefore, it would be important for the Peruvian State, to promote development, to develop public policies aimed at fostering innovation (Murrugarra Retamozo 2023b).

Similarly, it should be noted that one of the problems encountered when using AI with indigenous languages is the limited existence of data on that language, which means that the transcriptions of audio with AI automatic speech recognition (ASR) tools are not the most appropriate (Zevallos et al. 2022). In addition, most of the indigenous languages of developing countries are not currently considered by all the companies developing technologies applied to language. Hence, the exploration of technologies such as AI for their preservation is scarce (Camacho Caballero & Zevallos Salazar 2020). This situation is occurring in Peru.

After having carried out the contextualization of the problem, it will be appropriate to examine the legislative and public policy support in Peru for the preservation of Quechua and the potential linkage of this with the design and use of AI.

For instance, according to Table 1, although there are regulations that promote the teaching, dissemination, and conservation of indigenous languages, these still need to be in line with reality. In other words, objectives and strategies need to be defined so that indigenous languages are properly incorporated into the technological area. And, to do so, the problems related to the digital divide should first be solved.

Table 1. Analysis of the Peruvian legislation on the preservation of native languages. Own source

Laws and Regulations	Description
<p>Law No. 29735, which regulates the use, preservation, development, recovery, promotion, and dissemination of the native languages of Peru and its amendments.</p>	<p>The importance of native languages in Peru is specified. Therefore, within the framework of linguistic rights, people must enjoy the necessary guarantees to ensure that their languages are preserved, developed, recovered, promoted, and disseminated. Furthermore, the Peruvian State is responsible for carrying out a series of actions through the Ministry of Education to safeguard indigenous languages, using as an instrument the Ethnolinguistic Map of Peru, which helps to know the number of people who speak the different native languages of the country. Finally, two rights that Peruvians have are highlighted: a) to have the translation tools to ensure the exercise of their rights. Likewise, b) the right to obtain an education based on their mother tongue with an intercultural criterion. Thus, it can be inferred that the design and application of AI tools could serve to guarantee these rights.</p>
<p>Regulations of Law No. 29735, a Law that regulates the use, preservation, development, recovery, promotion, and dissemination of the native languages of Peru (Supreme Decree No. 004-2016-MC).</p>	<p>It is specified that indigenous peoples have the right to preserve and promote their knowledge on various topics, such as education, economics, health, art, etc., which must also be disseminated by different means. To achieve the above, it is emphasized that there must be coordinated actions between state institutions, the Ministry of Culture, and indigenous peoples. In addition, it is mentioned that the Ministry of Education should coordinate the necessary actions to ensure access to the correct resources for learning in native languages. Finally, it is emphasized that the Ministry of Culture is in charge of promoting and implementing the use of technologies to disseminate native languages in the State media. Although there is talk of the participation of indigenous peoples in the preservation and dissemination of their languages (for example, in the media), on the issue of implementing technologies such as AI or emerging technologies to preserve languages such as Quechua, there is no precision. It has only been found that it is the Ministry of Education that coordinates actions to ensure access to correct learning resources in indigenous languages.</p>
<p>Supreme Decree approving the update of the Ethnolinguistic Map: languages of the indigenous or native peoples of Peru - Ethnolinguistic Map of Peru (Supreme Decree No. 009-2021-MC).</p>	<p>This regulation refers to the Ethnolinguistic Map of Peru, which is an instrument that contains a series of quantitative and qualitative data on the people who speak indigenous languages in Peru. The importance of this instrument lies in the fact that it helps to carry out planning activities regarding the conservation, rescue, promotion, and dissemination of indigenous languages, depending on the state in which they are found. Thus, it would be understood that this map is a guide to the actions to be taken to preserve languages such as Quechua so that the use of technologies such as AI should be found in independent strategic plans or documents that have taken as a reference the state of the language (vital, endangered, etc.).</p>
<p>Legislative decree establishing actions for the protection of indigenous or native peoples within the framework of the health emergency declared by COVID-19 (Legislative Decree No. 1489).</p>	<p>This regulation, issued in the context of the COVID-19 health emergency, aimed to ensure respect for linguistic rights, especially in the provision of services by public entities. To this end, it called for the establishment of procedures, tactics, and measures to preserve, recover, and disseminate indigenous languages, considering the requirements and needs of indigenous peoples. The above takes into account the socio-cultural reality of the indigenous population. Although it should be mentioned that this norm does not mention specific strategies or actions, such as the acquisition of technologies for communication in native languages in public services. It only mentions that the Ministry of Culture, the National Council of Science, Technology, and Technological Innovation, and the universities must promote and favor the conduct of research and the dissemination of indigenous languages that are at risk of extinction.</p>

Supreme Decree creating the Interpretation and Translation Service in Indigenous or Native Languages for emergencies (Supreme Decree No. 012-2020-MC).	<p>This regulation established the creation of the indigenous or Native Language Interpretation and Translation Service for emergencies, to ensure that people who speak an indigenous language have access to assistance from state entities. The three interpretation and translation mechanisms are:</p> <p>In-person interpretation: an interpreter who knows native languages is allowed to communicate with users who are native speakers of such indigenous languages, to assist them with any request for a public service. All of this requires the people to be in the same physical location.</p> <p>Remote interpretation: an interpreter who knows native languages is allowed to communicate with users who are native speakers of such indigenous languages to assist them with any request for a public service. All of this is through technological tools such as cell phones or videoconferencing.</p> <p>Translation: it is a written service to translate various languages into indigenous languages. The writing and vocabulary rules are those authorized by the Ministry of Education.</p> <p>From the review of the standard, it can be said that these interpretation or translation systems are those that would be known as classic, still being limited to basic technological services. That is, there is still no innovation regarding the introduction of AI systems such as chatbots and similar.</p>
Supreme Decree approving the National Policy on indigenous languages, oral tradition, and interculturality (Supreme Decree No. 012-2021-MC).	<p>One of the guidelines of this policy is to promote the use, dissemination, and appreciation of indigenous languages through ICTs. This is because it has been proven that these technologies dynamize oral communication, which would help the indigenous population to disseminate and revitalize languages such as Quechua.</p> <p>Likewise, in this policy, there are reasons why technologies such as smartphones are important in the preservation of indigenous languages, such as access to the health system, access to educational opportunities, and having quality information, among others. And, it has been recognized that this can be stagnated by the digital divide, which largely harms indigenous peoples. Although it has been mentioned that a series of strategies must be developed for the preservation, dissemination, and revitalization of indigenous languages with technologies, the content of this policy, in this regard, is still novice. Furthermore, there are no further details of concrete and measurable actions on how technologies such as AI will be used to safeguard and revitalize indigenous languages (such as Quechua).</p>

In Peru, at the same time, there have been initiatives from the private sector to implement AI applications or tools in the Quechua language. This would reflect the possibility of preserving and revitalizing this language, such as, for example, the use of a data registry containing linguistic expressions and words in Quechua. Below is a description of the projects undertaken to preserve and promote the use of Quechua in Peru.

For example, according to Table 2, private projects are being developed in Peru aimed at preserving and disseminating indigenous languages. However, it is concerning that, at the state level, there are no projects that include the design of artificial intelligence systems that incorporate languages such as Quechua.

Table 2. Projects with AI developed in Peru to preserve Quechua. Source: López Linares (2024), Agencia Peruana de Noticias Andina (2024), Cueva Medina et al. (2024), Ojo Público (2023), Zevallos et al. (2022), Zevallos et al. (2020)

Project name	Description
Quispe Chequea	<p>It is a digital tool that creates informative verification material in indigenous languages in text and audio form, including Quechua, so that the Peruvian indigenous population can combat misinformation. To do this, it uses generative AI tools. What Quispe Chequea does is organize the data that the user has added textually with the particularities of a verification tool.</p> <p>Components of the Quispe Chequea AI tool:</p> <p>a) Production of verified material in text: texts are produced through a content manager that uses the ChatGPT resources. Here, the user has to enter fragments of information that have been verified in advance, plus other test components, so that the content manager writes a text. After the text has been produced, the editor is responsible for reviewing and adjusting it, and even adding information so that the content is of quality and verified.</p> <p>b) Audio production in indigenous languages: after the editor has approved the text, the desired language is chosen, Quechua, for example, and a key is pressed. Then, Quispe Chequea translates the content and provides an MP3 audio recording, which imitates the story of a commentator in Quechua.</p> <p>Challenges and complexities in designing Quispe Chequea:</p> <p>a. Difficulty in translating information into indigenous languages because translation resources are restricted.</p> <p>b. Creation of a translator for Quispe Chequea by developing a database with thousands of phrases for indigenous languages.</p> <p>c. Recording of the phrases in indigenous languages to have a sound bank of almost four hours per indigenous language (Quechua, Aymara & Awajún), to train the translator so that Quispe Chequea can transform the texts into audios.</p> <p>d. To develop the project, experts in journalism, translation, and data science were involved, as well as developers. This project was supported by the Google News Initiative (Lopez Linares, 2024).</p> <p>Effectiveness: It produces practical audio content and texts aimed at counteracting disinformation, although no specific technical performance indicators are provided.</p> <p>Language policy: With partial support from the Google News Initiative, it aims to expand access to information in indigenous languages; however, it operates more as a media strategy than as a well-integrated public policy, and community participation remains limited (Ojo Público 2023).</p>

Illariy	<p>It is an avatar developed with AI capable of presenting news in Quechua through the Letras TV Willakun channel, for the university population of the Universidad Nacional Mayor de San Marcos in Peru. To create Illariy, the AI tool Dall-E from OpenAI was used, which produces images from texts. Illariy would have an accuracy of between 50% and 80% in Quechua pronunciation.</p> <p>The avatar narrates the news in Quechua, thanks to the fact that a phonetic template of Quechua words is introduced to the D-ID system (AI platform), causing audios to be produced, or what would be the voice of Illariy narrating the news.</p> <p>Procedure for creating Illariy:</p> <ol style="list-style-type: none"> With Dall-E, an image of a woman with particularities of the Andean population of Peru was produced. For Illariy to speak fluently in Quechua, D-ID (a platform that allows images to be given life without movement) was used, making the image of the woman speak based on textual instructions. A phonetic template was created with words in Quechua, but the wording was done with words from the Spanish language. Then, the words were inserted into the D-ID database so that Illariy could speak. For this, a series of tests was previously carried out so that the sound of the words emitted by this avatar was similar to Quechua. <p>Challenges and complexities in the design of Illariy:</p> <ol style="list-style-type: none"> A phonetic template for Quechua was created because the text-to-speech AI platforms did not contain the indigenous language. Constant verification must be carried out regarding whether the news is narrated coherently and whether the sound is adequate (Lopez Linares, 2024). <p>Effectiveness: It generates content in Quechua fluently under the supervision of linguistic specialists; it has achieved a wide presence on social media and institutional platforms.</p> <p>Language policy: It seeks to promote the visibility of the language and combat technological discrimination. It has institutional support, although direct interaction with indigenous communities is not evident (Agencia Peruana de Noticias Andina, 2024).</p>
Quechua–Spanish translator with ASR	<p>This project aims to create a Quechua-to-Spanish translator using the Automatic Speech Recognition (ASR) approach, employing the HTK (Hidden Markov Model Toolkit) and the Siminchikkunarayku audio corpus.</p> <p>Effectiveness: It exhibits a word error rate (WER) of 12.70% in Southern Quechua, indicating solid performance for a language with limited resources.</p> <p>Language policy: It promotes the protection of linguistic rights and digital inclusion, although it faces obstacles such as a lack of funding and the absence of a state regulatory framework (Zevallos et al. 2020).</p>
NMT Transformer + QuBERT	<p>This project has two components:</p> <ol style="list-style-type: none"> A Transformer-based neural machine translation (NMT) model with LMfusion for translating from Quechua to Spanish. QuBERT, a Bidirectional Encoder Representation from Transformer (BERT) – which is a monolingual model for Southern Quechua. It uses Named Entity Recognition (NER) and part-of-speech (POS) tagging. <p>Effectiveness: The NMT model shows promising results, although specific figures are not provided.</p> <p>QuBERT, on the other hand, achieves between 71% and 74% on the F1 metric for named entity recognition (NER) and between 84% and 87% for part-of-speech tagging (POS), demonstrating performance comparable to that of systems designed for languages with a larger number of speakers.</p> <p>Language policy: Its objective is to promote intercultural communication and contribute to language preservation, but it does not incorporate clear mechanisms for the active participation of the communities (Cueva Medina et al. 2024, Zevallos et al. 2022).</p>

On the other hand, an important point to consider in this research is that there are serious challenges in developing AI language models for indigenous languages, including Quechua. This is due, for example, to the lack of available data for training such models. Currently, the data for these languages may be less than 10 million tokens. This prevents the construction of large-scale language models that perform optimally (Berment 2004).

In addition, a fundamental variable for maximizing the performance of language models with limited data is the quality of tokenization. This is important to mention because, according to Rust et al. (2021), linguistic tokenizers tend to oversegment words in minority languages, excessively dividing lexical units and hindering effective learning. Another aspect to highlight is that if the tokenizers were adapted to each language, the performance in natural language processing tasks would be enhanced.

If this issue is not addressed, it would be difficult to produce accurate linguistic representations, leading to unreliable translations and a reduced ability to generalize these translations to new contexts or dialectal variations (Rust et al. 2021, Zhang et al. 2020).

Furthermore, failing to resolve this problem could restrict speech recognition and text generation through AI, making it impossible to include common and unique expressions from each community in these systems (Cusilayme Barrantes et al. 2023). Additionally, the cultural aspect of how people who speak these languages interact with their worldview may not be captured by AI, since it is a tool that organizes data quantitatively (Lucas et al. 2025).

Likewise, while AI may help to quickly document and teach indigenous languages, this does not guarantee their long-term sustainability. Such sustainability is ensured by the frequency with which the language is used in the communities and the level of commitment to its use through public policies. In other words, AI

is a helpful tool, but not a motivator or guarantor of the social interaction that people have with a language (Sharma 2025).

It must also be emphasized that translating with AI systems is not simply showing what words look like in another language; it is reflecting the worldview of the people who speak it, their cultural references, and their communication processes. In other words, it involves contextualization. If these aspects are not considered in such tools, the translations will be empty and erroneous (Azizov 2024). In this sense, it can be said that translations that are usually done without considering these cultural contexts result in distortions in communication (Anik et al. 2025).

What's more, it should be considered that some research indicates that, on the contrary, AI would exacerbate inequalities, as it would impose notions alien to those that indigenous communities are accustomed to. This produces an exclusion in which, in many cases, the participation of indigenous populations is simulated, but without involving them in the design. Nor is it guaranteed that the communities have sovereignty over their data, and their language is used only for experimentation. Similarly, the lack of intercultural communication and the ignorance of the needs of these populations show that AI would only serve as a project whose priority is metrics. This, of course, leads to a disregard for the cultural and pedagogical processes of each community. Furthermore, although the creation of materials in indigenous languages may be perceived as a benefit of AI, if there is no constant cooperation and cultural adaptation of what is produced, the use of such technology could be seen as invasive. Therefore, the notion of revitalization should not be measured by the number of AI applications created for these languages, but rather by their ability to transfer power, strengthen their community use, and preserve the social ties that sustain the languages in their environments (Lewis et al. 2024, Blayone & Mykhailenko 2025, Perera et al. 2025, Soylu & Şahin 2024, Zhu et al. 2024).

Based on what has been discussed so far in the research, the question arises: why is it important to preserve a language like Quechua in the world using AI? While it might be thought that revitalizing this language is essential only in local terms (Peru), this is not entirely true, as its influence is transnational and linked to global dynamics. A clear example of this is what Mendoza Mori & Sprouse (2023) demonstrated, showing that the language is spreading to the United States through diasporas. This is supported by programs such as the Quechua Alliance, which promotes linguistic education and cultural affirmation. Kvietok & Hornberger (2023) have also emphasized the need to implement policies that recognize the transnational effect of Quechua due to its presence in the United States and Ecuador, reflecting the linguistic and social diversity of the Andean language.

Similarly, Hornberger & Coronel-Molina (2004) have stated that Quechua is a language present in six nations, which makes it necessary to consider its revitalization from a transnational perspective. Furthermore, the authors have indicated that the migration of people who speak this language is changing linguistic interaction; therefore, technologies must consider these aspects and incorporate diverse variants and contexts.

Moreover, Zavala & Andrade Ciudad (2023) have discussed the existence of innovative Quechua activism, where young people express their views on the State digitally. Given this, it can be said that Quechua is a language that must be addressed within the context of globalization, since it already has a digital presence and is even used in academic settings (Haboud Bumachar & Narváez Burbano 2022). What the authors have expressed leads to the conclusion that the revitalization and preservation of Quechua through AI cannot be seen as an isolated or solely local issue, but rather as a global and inclusive one.

Subsequently, understanding the preservation of Quechua in the digital world with AI also involves highlighting the exact role that translation plays here. The answer lies in the fact that virtual translators are currently using AI systems at an accelerating pace (machine translators). This is fundamental in the case of the preservation of indigenous languages because it must be understood that the practice of translating with such tools does not only depend on linguistic codes, but also incorporates cultural aspects, identity, and access to these systems. In the case of machine translators, thanks to AI, the way in which people can access languages and generate content in various languages has expanded. However, these translators can also tend to standardize expressions, since priority is usually given to more general linguistic variants. Therefore, it has been suggested that their use should incorporate mechanisms that include working with communities that are aware of the cultural diversity inherent in each language (Sarvaiya 2025, Mager et al. 2023).

From a translation studies perspective, this can be understood as the act of translating certain languages or terminologies being a political and cultural decision that has an impact on linguistic rights (especially in indigenous languages). Therefore, the presence of translators (localizers) and native speakers of the languages is a conditional factor in ensuring that AI serves to preserve languages and that machine translation does not merely lead to a reductionist standardization (Mager et al. 2023, Pinhanez et al. 2024).

It should also be noted that machine translation of indigenous languages presents ethical issues that need to be addressed, such as informed consent, data ownership, permissions, and even how indigenous representation is projected through such translation (Mager et al. 2023). This reinforces the point made in the previous paragraph about the need for cooperation from native speakers and localization experts. Their involvement should be present from the data collection stage to its validation to avoid biases and extractive practices (Pinhanez et al. 2024).

This previous statement is because, in general, people's right to protect their data must be safeguarded (Murrugarra Retamozo 2022), especially against technologies like AI that have demonstrated risks (Murrugarra Retamozo 2024c), such as, for example, unauthorized access and manipulation (Murrugarra Retamozo 2024d). It is also important to prevent situations of digital violence (Murrugarra Retamozo 2023c) that may be experienced by those who express themselves in their own languages through digital platforms.

Finally, for machine translators to include the various variants of Quechua, localization is also required to address the management of different terminologies and their equivalents in digital environments (educational materials, interfaces, etc.). Similarly, in this translation and localization process, it is necessary to avoid arbitrarily imposing a single rule on which variant to use; instead, the use of the different variants that exist should be prioritized (Ríos 2015, Font Llitjós et al. s.d.). In the specific case of Quechua, there are advances in technological architectures called Transformers, which allow for morphological segmentation and semi-supervised tactics (based on AI) to incorporate variants, in addition to web interfaces that allow for the translation of Quechua into Spanish (Cueva Medina et al. 2024).

2. Research methodology

The proposal to address the research is through the realization of a study that includes a set of interviews. The interviews include two (2) Quechua speakers, one (1) person who specializes in teaching Quechua in Peru, and two (2) experts who work in localizing indigenous languages for technologies. Ideally, these people, through their knowledge, will express their opinions and perspectives related to the challenges, opportunities, and implications of the development of AI tools to preserve native languages such as Quechua in Peru.

In this study, we applied a qualitative approach. This is because, in addition to collecting detailed data provided by the subjects interviewed, as well as the environment that surrounds them, we aimed to carry out an interpretation of said information. (Younas et al. 2023). In other words, the interaction with Quechua speakers, experts in localizing native languages for technologies, and the person experts in the development of materials and projects for the promotion and preservation of Quechua in Peru, will allow us to know what their points of view are about the problem studied.

Regarding the research method, we applied the ethnography because it helps to establish an interaction with the study participants, making it easier for them to reflect on themselves and their experiences. Additionally, using this technique is appropriate because it allows for establishing a closer and more open relationship with the interviewees' environment (Di Feliciano 2023).

Likewise, we used the case study design because this design examines the problem in detail with the people involved in it. Additionally, one of the particularities of this design implies that a population and what happens in it could be studied. Also, it must be remembered that a case study helps to describe a problem in detail in its real environment, which is why it becomes a descriptive-level study (Priya 2021). All this is what we intended with this research by taking the problem of the danger of extinction of Quechua in Peru as a real issue, using evidence about the language, the actions undertaken to safeguard it, and the potential use of AI in that context.

2.1. Data collection technique and instrument

In the project technique, we used semi-structured interviews, which help to know the less visible elements of reality, formulating questions for the research participants (Belina 2023). That is, the aim is not only to review bibliographic materials that portray the situation of the Quechua language in Peru and how its vitality can be preserved with AI, but also to interview people who know what circumstances such a language is going through in the country. To do so, we added the view of a specialist in the design of materials in Quechua and the localization experts.

2.2. Procedure for collecting and evaluating information

First phase: we prepared the questions for the semi-structured interview to understand the challenges, opportunities, and implications associated with designing and using AI tools to preserve the indigenous Quechua language in Peru.

Second phase: we contacted the interviewees via email and WhatsApp to schedule virtual interviews via Zoom. The goal was that they would provide testimonies based on their experiences. The interviews lasted approximately thirty (30) minutes per participant. We conducted the interview stage between July and August 2024.

Third phase: for the analysis of the responses provided by the interviewees, we structured the data from the interviews with Quechua speakers and Quechua experts into five (5) sections. We also structured the data from the interviews with the localization experts into five (5) sections. Next, the method for evaluating the data consisted of three (3) stages: 1) the summary of the data, 2) the structuring of the textual information, and 3) the analysis of the results. In stage number one (1), we organized the data collected through the inductive-deductive method, which, through reasoning, helps to move from a particular knowledge to a more general one (Rodríguez Jiménez & Pérez Jacinto 2017). Next, we categorized the data through a logical criterion, and finally, we structured the information.

The sections into which the information was grouped were for each group of interviewees. The following were included: First group (Quechua speakers and Quechua experts): I. Perspective on the situation and preservation of Quechua in Peru, II. Implementation of technology programs and projects, including Artificial Intelligence, to preserve native languages, such as Quechua in Peru, III. The role of Artificial Intelligence in the preservation of native languages, such as Quechua in Peru, IV. Understanding of the possible use of Artificial Intelligence technologies by the population to preserve native languages such as Quechua in Peru, and V. Artificial Intelligence as a factor of inclusion and promotion of multiculturalism in the preservation of Quechua in Peru. Second group (localization experts): I. Perspective on the use of Artificial Intelligence in localization and translation, II. The role of Artificial Intelligence in the preservation of native languages, such as Quechua

in Peru, III. Implementation of technology programs and projects, including Artificial Intelligence, to preserve indigenous languages, such as Quechua in Peru, IV. Understanding the potential use of Artificial Intelligence technologies by the population to preserve indigenous languages such as Quechua in Peru, and V. Artificial Intelligence as a factor of inclusion and promotion of multiculturalism in the preservation of Quechua in Peru.

Table 3. First group of interviewees - Quechua speakers from Peru and a Quechua expert. Own source

Identification of the interviewees	Country	Profession or occupation
Interviewee 1	Peru	EIB teacher
Interviewee 2	Peru	EIB teacher
Interviewee 3	Peru	Quechua expert

* EIB (Intercultural Bilingual Education system of Peru).

Table 4. Second group of interviewees - people with expertise in localization or translation. Own source

Identification of the interviewees	Country	Profession or occupation
Interviewee 4	Brazil	Localization expert
Interviewee 5	Zimbabwe	Localization expert

3. Results and discussion

The research findings are divided into two groups. The first group contains a summary of the interview responses from Quechua speakers and an expert on Quechua teaching in Peru. The second group contains a summary of the interview responses from experts in localizing indigenous languages for technology. With each result of those interviews, we are elaborating a discussion of the answers following the scientific method, which will be compared with the results of other investigations.

First group: Quechua speakers and an expert in Quechua.

Perspective on the situation and preservation of Quechua in Peru

Result 1: Quechua is a current language in Peru that reinforces the country's cultural identity. Its strengthening and revitalization are important to respect the linguistic rights of the Quechua-speaking population.

Discussion of the result 1: Quechua is among the 48 vital indigenous languages of Peru. Its importance lies in the fact that it allows us to learn about the history and culture of Peru, and it is increasingly common to hear this language in universities. And, although the data from the last census in 2017 indicate that it is in danger of extinction, currently in rural areas, Andean families are teaching the new generations to speak Quechua, letting them know that they have linguistic rights that must be respected.

In this regard, Interviewee 2 (2024) stated the following:

I do not consider [Quechua] to be in danger of extinction, because one of the threats to this was discrimination, which made many parents not teach Quechua to their children, but that is now changing.

About this, Torres Verano & Romero Zanabria (2022) mentioned that the dissemination of Quechua is not only important for the Quechua-speaking population but also because it allows preserving the cultural richness of a country where several languages converge. This is also relevant to what has been found in the opinion of Zuna Llanos (2017), who pointed out that to promote Quechua, it is important to have specialized instruction in its teaching and thus disseminate knowledge in that language.

Result 2: For years, Quechua speakers have suffered discrimination, making preserving and disseminating their language difficult. However, currently, there are ways to disseminate Quechua, giving it the importance it deserves. But there are still some difficulties at the state and private levels in preserving the language.

Discussion of the result 2: Previously, there was a lot of marginalization towards Quechua speakers for speaking their language, which, fortunately, with the Intercultural Bilingual Education system of Peru (EIB), is being overcome. Currently, Quechua speakers can find work as interpreters, translators, and creators of materials in Quechua. Likewise, through social networks, the new generations are spreading the language and helping to revitalize it. However, at the state level, there are still difficulties in preserving and disseminating Quechua, such as inefficient laws and public policies that limit the inclusion of Quechua in people's daily lives. Likewise, at the private level, when projects are undertaken to teach Quechua, there is no specialization in the materials and audiovisual content produced.

In light of this, Interviewee 1 (2024) expressed:

The Quechua speaker has been marginalized; it has been forbidden to speak Quechua. It is important to be able to strengthen our national cultural identity as Peruvians and to find our roots and history. The work of the [Peruvian] government through the EIB is commended.

This finding coincides with Silva (2023), who considers that it is important to have Quechua in the educational system, but for this to be effective, attention must be paid to developing public policies with an intercultural focus. This will help to ensure the validity of Quechua and, therefore, Peru's cultural identity. Furthermore, according to Blácido (2016), although policies for the inclusion of this language have been developed, they are still weak because they have not been able to transcend to vindicate Quechua.

Implementation of technology programs and projects, including Artificial Intelligence, to preserve native languages, such as Quechua in Peru

Result 3: The Peruvian government has developed technology projects and programs to teach and disseminate Quechua. However, initiatives to incorporate Quechua in technology do not usually include Quechua speakers, and technological applications that include the Quechua language are not dynamic.

Discussion of the result 3: The Peruvian government has implemented technologies so that Quechua-speaking students can strengthen their communication skills in that language, with Quechua applications such as CHACHAS and WIÑAY. The Peruvian government has also provided tablets. Similarly, to teach Quechua on Peruvian television, the RIMAYNINCHI program was included, and an application was created to promote trade between Quechua-speaking consumers and producers. All of this has been complemented by initiatives by the Peruvian Government to teach Quechua under the EIB, training teachers to teach Quechua and strengthen their pedagogical skills in the language. In allusion to this, Interviewee 1 (2024) expressed:

In the educational field, started in 2016-2017, an EIB service accompaniment program, Intercultural Pedagogical Support Companion (ASPI), where the competencies of teachers who teach Quechua have been strengthened (...). From the government, there are programs, such as virtual courses in Quechua, so that bilingual teachers continue to strengthen their communication skills.

However, it seems that the initiatives to create technologies in Quechua are done just to comply because they do not work with Quechua speakers for their development. In addition, the applications that are created are not so dynamic, making those who are learning the language bored, which would make it seem that more investment is needed for these projects. As Interviewee 2 (2024) said: "In the government, there is basic support, such as tablets, for rural areas (...). There are applications in Quechua, but they are not so dynamic, and it does not motivate carrying out activities in those applications."

Regarding this finding, Huamani Huamani (2019) expressed that the EIB policy helps students residing in rural areas to receive a quality education, which at the same time allows for preserving the indigenous legacy that corresponds to them through knowledge imparted in indigenous languages. However, Herrera Corahua (2022) found that Quechua-speaking students could lose their language because the EIB does not have effective policies for teaching Quechua, and the projects created are more idealistic than real.

Result 4: At the governmental level, there are still no projects to develop AI tools that include the Quechua language. The obstacles are the low budget to implement technology projects to preserve this language and the non-inclusion of Quechua speakers and experts in the development of such AI tools.

Discussion of the result 4: At the state level, there are still no AI projects to preserve Quechua; there are only proposals that are developed by the teachers themselves, such as the KIPi robot of a Peruvian teacher. When teaching Quechua, teachers use their own AI resources to create illustrations and materials in Quechua. One of the obstacles to implementing AI projects in Quechua is the low budget allocated by the Peruvian Government to the EIB. There is also no institutional support to investigate how AI can include Quechua for its teaching, nor training for people who are experts in the creation of AI to learn Quechua and thus develop tools considering the contexts of Quechua speakers. Ideally, the Peruvian State would provide more budget to include an agenda with AI projects to preserve Quechua, and that this be done with periodic audits. It is also necessary to include Quechua speakers and language specialists in the development of this technology. Regarding this, Interviewee 2 (2024) noted the following:

At the Peruvian government level, we would be at zero to develop AI projects to preserve Quechua. There are proposals from teachers, such as a teacher who made stories in Quechua using AI for illustrations, but these are individual proposals. I also use AI in my school to do activities, but it does not come from MINEDU or training to do something with AI.

The same general perspective from this finding is addressed by Rafael Pérez et al. (2019), who argue that the use of AI applications would assist in preserving indigenous languages to be preserved. This also highlights the opportunity to call on indigenous communities to collaborate in the design of these tools, thus generating social and cultural integration.

Result 5: To develop AI tools that integrate Quechua, it would be essential for the Peruvian State to work in collaboration with private institutions developing AI technologies that are already creating AI programs that include Quechua. And it must be ensured that such cooperation is efficient and swift.

Discussion of the result 5: Technology companies developing AI have been doing a good job in trying to include Quechua. Such is the case of the applications created to learn this language, such as the SIMI application in Bolivia, or the QichwaDic dictionary. Some universities have designed an audio bank with thousands of hours of voice in Quechua to use in a translation program. However, Interviewee 3 (2024) noted that: "There is no public or private institutional support that provides advice and auditing of these AIs, there are no research centers in Quechua with research agendas in Quechua and with a budget to create AI in Quechua and teach it". Therefore, the Peruvian Government must approach these private institutions and establish an articulated collaboration plan, so that Quechua is taught, disseminated, and strengthened with AI. Also, the Peruvian State should communicate to these institutions the objectives and scope of AI projects

in Quechua. Nevertheless, due to state bureaucratic issues, this collaboration with private institutions and technology companies may be hindered. Therefore, if such cooperation is to exist, it must tend to be fast and efficient and always include the perspective of Quechua speakers.

This finding is similar to that presented by Aguilar Santiago & García Zúñiga (2023), who stated that for some time now, digital projects have been working on incorporating indigenous languages, either by governmental or private initiatives that wish to progress in the application of PLN in this field. Such initiatives have been aimed at an inclusive approach to indigenous languages, or more importantly, have been proposed by the indigenous communities to preserve their languages and transmit their cultures. Similarly, the collaboration between private institutions and the States, where native languages abound, is something that should be highlighted based on what was stated by Llanes Ortiz & Huiza Capo (2023), who pointed out that it is imperative to test whether the technological resources implemented in these languages will be adequate or not, due to the operating costs, the quality of connectivity, the Internet access that exists in the communities where the technologies will be used and the use that will be made of them. This undoubtedly requires collaborative work with the indigenous populations as well.

The role of Artificial Intelligence in the preservation of native languages, such as Quechua in Peru

Result 6: AI can help as a recording tool for the recovery and strengthening of Quechua.

Discussion of the result 6: Language must be inserted into technology, and the best way to do this is with AI, which allows us to create various digital resources in Quechua. Likewise, as a recording medium, AI could serve to transmit this language intergenerationally, so that people learn Andean customs, uses, and knowledge. In addition, it must be considered that since AI is a discursive product of text, voice, or audiovisual material, the way to test whether the representation of Quechua made in this technology meets expectations is for each of those who participate in the development team of AI programs in Quechua to know the language. Thus, Interviewee 2 (2024) mentioned the following:

[AI technologies] are means of recording. Previously, the original languages were of oral tradition, with some textile sources or signs in nature, and that is how the language was transmitted. But now, with the implementation of writing, [the language] can be recorded, and with technology, even more.

This finding is very much in line with Cruz (2021), who revealed that technologies such as AI can help increase the glossaries of minority languages. For example, translators using AI systems will speed up the process of revitalizing and preserving a language, while automation systems will help make texts consistent and coherent, alleviating the work of localizers. As an example, the use of PLN in indigenous languages is important because of the ability of these systems to process, understand, evaluate, and produce human language. This could be used to design digital dictionaries with indigenous words, detect patterns in indigenous grammar, and analyze the grammatical structures of these languages. PLN can also record the grammar of indigenous languages and develop translation systems to disseminate indigenous languages (Metaversos Agency 2024).

Understanding of the possible use of Artificial Intelligence technologies by the population to preserve native languages such as Quechua in Peru

Result 7: Developing AI tools in Quechua would be beneficial for non-Quechua speakers to learn the language and the Andean reality. As for Quechua speakers, they could strengthen their knowledge of their language in interactive ways with such technological tools.

Discussion of the result 7: Non-Quechua speakers who have Spanish as their mother tongue could learn Quechua with AI and the Andean reality, because this tool provides a more dynamic way of learning. It has been shown that using digital tools creates more fruitful learning, especially for children, because they can then teach the knowledge they have learned to their family members, so that they can also learn Quechua. Concerning this, Interviewee 2 (2024) said: "I think it is a very valuable tool, as long as you have the guidance and know how to use it, to create and generate many things from the native languages, the Andean cultures". In addition, AI would allow those who are learning the language not to have to go into a community to acquire the language. For Quechua speakers, using AI devices would be a nice experience because AI in Quechua will allow them to strengthen their knowledge of their language with interactive elements that are adapted to their realities and contexts.

This finding coincides with the study by the Fund for the Development of Indigenous Peoples of Latin America and the Caribbean and the Regional Observatory for the Rights of Indigenous Peoples (2020), where it was stated that indigenous languages have been occupying places in the youth sphere due to their dissemination in social networks such as YouTube, Facebook, Instagram, and even digital apps. This situation has also allowed the dissemination of content related to the importance of implementing revitalization strategies. About the use that Quechua speakers could make of AI, the research by Chávez Ángeles et al. (2020) has argued that the use of technologies by indigenous peoples would allow them to disseminate their knowledge to non-speakers of their languages, and that, at the same time, indigenous populations would learn to make use of technologies. This would ensure that an intercultural approach is established through the exchange of knowledge.

Result 8: Among the obstacles for people to use AI to preserve Quechua are the digital divide, the few initiatives to add Quechua to AI, and the lack of inclusion of Quechua speakers or experts in Quechua in the design of technologies such as AI.

Discussion of the result 8: If Quechua speakers living in rural areas wanted to use AI in their language, they would have difficulties related to the digital divide, such as poor connectivity, lack of light, lack of electronic devices, etc. Another difficulty that would be encountered in preserving Quechua is that, for the

most part, the resources with which AI is designed are in English or Spanish, and there are no resources or data in Quechua for AI. On the other hand, there could be some difficulty in understanding Quechua in AI if this tool is developed with little participation from Quechua speakers and Quechua experts, because in many cases it is common to see that Quechua technologies are only developed with technicians and not including the Quechua-speaking population. In this regard, Interviewee 3 (2024) stated the following:

The main limitation for the state to create AI to preserve Quechua is the absence of technical teams of people who master the Quechua language, that is to say, they do not know Quechua. Those who are trained in Quechua should do so through scientific knowledge that allows them to create AI.

Such findings are consistent with what Anaya Figueroa et al. (2021) found in their study, which revealed that, in the rural area where indigenous language speakers live, technological or non-technological materials or resources are adapted and even elaborated by teachers because, when they are provided by the government, they are not adapted to the reality of the population. At the technological level, the authors stated that if technological tools (such as AI) are provided in indigenous languages, the lack of technological infrastructure, the shortage of digital equipment, and the issue of connectivity must also be solved. As Jiménez Deferia (2024) rightly pointed out, the use and application of AI in indigenous education are complicated by the inequalities faced there, such as the lack of access to cutting-edge technologies, which reflects the lack of opportunities.

Artificial Intelligence as a factor of inclusion and promotion of multiculturalism in the preservation of Quechua in Peru

Result 9: Incorporating Quechua in AI would make Quechua speakers feel included, empowering them to show the importance of their language, which would also make them feel that they are represented in the technology.

Discussion of the result 9: It has been shown that Quechua is a language that is at the level of other languages, making there increased research to include it in academic spaces and the development of technologies. Therefore, thinking about the design and use of AI tools that contain Quechua would give it the space that this language deserves, making Quechua speakers feel that they exist and are present. The best way to achieve this would be through the promotion of projects and applications to teach Quechua, and always with initiatives that come from the Peruvian State. As Interviewee 1 (2024) rightly said: "Nowadays it is already common to hear in [different spaces]. We are assimilating and respecting the linguistic richness and expressions of our variants.

Regarding the transcendence of including Quechua in AI, it can be mentioned what Basualdo & Gómez (2018) referred to, who expressed that learning Quechua reinforces Peruvian cultural identity. Moreover, preserving such language has a valuable meaning, since it represents the millennial knowledge, values, and concepts of the ancestors of Peruvians, which must be taken care of. Moreover, due to technologies, indigenous populations have acquired the option to raise their voices, communicate through social networks, disseminate information, preserve their histories, make their cultures known, and revitalize their languages, thus allowing them to get involved in political and social causes (Peñuelas Peñarroya 2022).

Result 10: Including Quechua in the IA would imply demonstrating that in Peru, all cultures, including Andean culture, are important. In this way, the prejudices that have been held against Quechua speakers would also be set aside, and to achieve this, public policies are required.

Discussion of the result 10: Incorporating Quechua in AI tools would reflect that in Peru, all cultures, including the Andean one, are relevant; and for this reason, this language should be present in all instances, such as technology. According to Interviewee 3 (2024): "In the private sector, some universities have taken the initiative to establish an audio bank with thousands of hours of Quechua speech for use in an effective translation program". For example, today it is young people who are inserting Quechua in digital spaces, showing that Peru is a multicultural country and that their linguistic rights matter. And, if the Peruvian Government were to develop effective public policies so that AI applications and programs are developed in Quechua, this would, in turn, contribute to normalizing those indigenous languages that can also be present in these spaces and thus preserve their vitality.

In this case, the study by Pozo Quimi et al. (2024) showed that the inclusion of indigenous languages in digital spaces would make it possible to overcome linguistic and geographical barriers to understanding between societies. This is because, when these languages are disseminated, a sense of empathy and respect for the populations that speak these languages is produced, thus generating an environment of cultural exchange. Hence, the importance of policies that help the dissemination of these languages. Similarly, the inclusion of indigenous languages is important because it allows communion and creates bonds of support with the indigenous locality, also because the inclusion of these languages in digital spaces helps to have broad and varied perspectives, which enables reconciliation between the Andean and Western worlds (Ferguson & Sidorova 2023).

Second group: is experts in localizing indigenous languages for technologies.

Perspective on the use of Artificial Intelligence in the area of localization and translation

Result 1: In the area of language localization, AI has been used because of its advantages, such as speed of translation and glossary creation, facilitating the work of localizers. However, in the case of the localization of minority languages (such as Quechua), there is still not much content that helps to localize properly.

Discussion of the result 1: In the area of language localization, different types of AI tools have been used for a long time, allowing the creation of glossaries, identifying repeated words, and providing quick answers in translations, which has facilitated the work of localizers. In addition, AI has helped to give consistency to the terms of various languages. However, there are disturbing aspects regarding minority languages, and it

is that in AI tools, there are still no resources that allow understanding the context of such languages. The above would reflect a lack of common commitment to generate resources that help minority languages have greater participation and representation in the world of technology. As Interviewee 4 (2024) rightly said: “If we talk about the application of AI in localization, we have already been using different types of AI (...)”.

The referred finding coincides with what Sánchez (2024) found, that, in indigenous languages such as Mayan, there is not enough public data to aggregate to AI, which would also be the case for Quechua. For example, Mager et al. (2024) in their research found that the implementation of automatic translators in the case of indigenous languages is essential for people who speak these languages to communicate easily. However, they reported that the problem in implementing machine translation in these languages is not only due to the availability of data but rather to the diverse dialect variations in these languages, orthographic complexity, and intricate morphology, among others.

Result 2: AI in the area of localization presents challenges, such as overconfidence in using large linguistic models (LLMs) for translation, and the exclusion of minority languages. But there is also an opportunity, such as a genuine inclusion process for people to use LLMs to translate their languages, which should be done by including the voices of localization experts.

Discussion of the result 2: Currently, there is an excessive application of AI LLMs to translate various languages, not considering that these tools do not yet have full knowledge of the context and cultural nuances of the languages they translate. Interviewee 5 (2024) stated that: “[There is] overdependence on a technology that is still learning or cannot learn the context and cultural nuances”. In addition, minority languages still need to be included, and the accessibility problems that using AI represents for certain people (who could contribute to validating the translation done by LLMs) need to be solved. Meanwhile, opportunities to use AI in this area include ensuring that there is an investment dedicated to improving the translation systems that use AI and the genuine inclusion of languages in AI systems. All of this must be done by ensuring that, when these types of technologies are developed for localization, localizers and people in charge of translation are integrated. This is so that they can express their suggestions on how to improve AI and thus reduce the inherent biases it has.

This coincides with Urrere (n.d.), who mentioned that the lack of governmental support for the preservation and dissemination of indigenous languages makes it difficult to integrate linguistic data into the digital world. In addition, this lack of support also means that, if linguistic data is found, it is not entirely reliable because it does not have the correct validation, as may be the case with LLMs. Similar perspectives were portrayed by Murrugarra Retamozo (2025), who expressed that the development of AI technologies in language teaching presents difficulties linked to the operation of such systems because the fact that AI models are mostly trained in predominant languages restricts the ability of such systems to understand the contexts of other languages.

The role of Artificial Intelligence in the preservation of native languages, such as Quechua in Peru

Result 3: AI could preserve Quechua, but the Quechua-speaking population would need to be consulted if they want their language to be included in such technology. In addition, the Quechua-speaking population would have to validate the content created for their knowledge to be protected.

Discussion of the result 3: If Quechua-speaking populations are contacted to create a record of their language, to later insert it into tools such as LLMs, AI could serve to preserve Quechua. However, it is necessary to include Quechua-speaking people and ask them if they want to be seen, and if they want their knowledge (culture and values) to be shared with technologies such as AI. And, if this population accepts, only then can content and registration of their languages be created, always ensuring that the population validates what is elaborated. Given this, Interviewee 5 (2024) stated that “[There are] access issues for people who could contribute more deeply to building the space and technology in a way that is beneficial to the end user”. Validation and consultation with the Quechua-speaking population is important because, currently, AI is being used to harm, as with the biases it has, calling into question whether the language would be safer in the spaces of the Internet.

Such evidence coincides with Meighan’s (2021) claim that the role of technology as a revitalization mechanism needs to pay attention to how technologies are being fed with indigenous language data, who are developing these technologies, and how they will be used. This premise is because, many times when these tools are developed, indigenous populations are not taken into account, and the creation of these technologies tends to have a capitalist and imperialist approach. About this, Pinhanez et al. (2024) mentioned in their research that, in addition, for AI systems to be fed data in indigenous languages, the permission of the communities that speak those languages must be obtained for the use of such data.

Implementation of technology programs and projects, including Artificial Intelligence, to preserve indigenous languages, such as Quechua in Peru

Result 4: The implementation of technologies such as AI that include Quechua represents a great opportunity to create a database with essential elements of the language, which will allow its preservation.

Discussion of the result 4: AI can be used to create a database containing vocabulary, sentence grammar, and real content in Quechua, and insert this into the LLMs. All of this could be achieved if the localizers work together with the indigenous populations, because their authorization must be obtained to create content in their language. In response, Interviewee 4 (2024) alluded that: “[It is necessary] to contact the communities (...) and local organizations that work to preserve the languages to use AI and thus have a library of written content or records of spoken Quechua”. This will allow languages to be preserved for future generations through documentation and personalized language learning with the help of AI; clearly, by training indigenous populations to use them.

Concerning the aforementioned finding, according to Ajani et al. (2024), websites such as the Living Languages Institute for Endangered Languages are supporting projects that seek to create technologies that bring together materials and resources that serve to document indigenous languages. A key example of the use of linguistic data from indigenous peoples is the case of the Te Reo language (Polynesian language), for which automatic speech recognition systems have begun to be developed. The project has been developed thanks to the technological resources promoted by NVIDIA NeMo and NVIDIA A100 Tensor Core GPU (Lee 2024).

Result 5: Among the drawbacks of the implementation and use of AI to preserve Quechua are: the limited participation of indigenous populations to incorporate Quechua in AI, the scarcity of linguistic data in Quechua, and the linguistic complexity of Quechua.

Discussion of the result 5: There may be drawbacks to the implementation and use of AI tools in Quechua if their development is not done with the consent of indigenous populations. It should be considered that, when creating a tool that contains their language, they should be invited to participate so that the existing content reflects their contexts and practices. To this, Interviewee 5 (2024) mentioned:

If concerted efforts are made, AI can serve to preserve native languages. This requires an inclusive process in which native language speakers choose to go online to be seen, heard, and share their culture, values, and systems with the world.

And, if companies like Google or other technological giants only decide to borrow some content written in Quechua from the Internet, and then extrapolate it to generate content in Quechua, that is not correct. This is because the ownership of indigenous data is not being respected. The above also reveals the existence of a scarcity of data and linguistic complexity of Quechua, which could be corrected by including these populations to create true content of the language.

Regarding, Le Mur & Moya (2024) proposed that including indigenous languages in AI systems should be done to form more diverse groups, which include indigenous communities; this would also help to curb biases in linguistic data. In addition, requesting permission from indigenous communities for the use of their linguistic data is an essential aspect if technologies are to be implemented with these languages because many times the licenses with which their use is authorized tend to violate the linguistic human rights of these communities, not conforming to the parameters of the digital economy that requires the granting of such permissions (Moshagen et al. 2024).

Understanding the potential use of Artificial Intelligence technologies by the population to preserve indigenous languages such as Quechua in Peru

Result 6: People can learn languages such as Quechua through AI, as long as the design of this technology is validated by the indigenous populations that speak these languages.

Discussion of the result 6: People can learn indigenous languages using AI tools, if it is done well. For example, when Indigenous languages are implemented in LLM systems, constant validations must be carried out with the participation of indigenous populations to ensure that the content in Quechua is correct and to see if the LLM models are learning the characteristics of the language. This will allow people to learn these languages easily using personalized learning platforms and translation tools. As Interviewee 4 (2024) rightly expressed: "That is why [when developing AI technologies with indigenous languages, developers] should go back to the communities, and this should be done repeatedly to validate the content created in Quechua".

This finding coincides with what was referred to by Olaare (2024), who suggested that platforms that include indigenous languages must have the cooperation of the native communities. This would allow these populations to communicate and narrate their experiences, creating at the same time a digital linguistic repository that would help to feed the AI. This also coincides with Vorecol's (2024) statement that joint work between linguists, software development companies, and indigenous populations can contribute to having individualized technologies that portray the socio-cultural contexts of such populations. Such technology development could not only revitalize indigenous languages but also promote an intercultural approach.

Result 7: The challenges for AI to be used to learn and preserve languages such as Quechua are the need for a commitment from technology companies to develop AI tools in indigenous languages, the need for public policies for the inclusion of indigenous languages, and the promotion of respect and inclusion of indigenous populations in the development of technologies in their languages.

Discussion of the result 7: A true commitment is needed from technology companies to create AI tools that preserve indigenous languages. This is because, although these companies can invest money to develop these tools, their priority is always based on the predominant languages. Therefore, for indigenous languages to be included, there should be more work on public policies designed to incorporate languages such as Quechua. In addition, it would have to be seen that these tools are accessible, are created without bias, and protect the ownership of linguistic data. All of this implies that indigenous populations participate in the development of these technologies in their languages. On this, Interviewee 5 (2024) expressed:

A world where deepfakes and AI are used to harm calls into question whether language is safer in spaces where AI exists. But this is precisely why indigenous populations are involved in the development of these technologies in their languages.

A similar assessment is found in the research of Santaella (2021), who pointed out that tools such as AI are replete with data from the global north. However, what technology companies should do is include data from Latin America and the Caribbean in the development of these technologies. This would help improve the region's production chain at the technological level. In this regard, Mescua Figueroa et al. (2024), emphasized

the development of public policies for digital inclusion, governments have to consider allocating a properly planned budget that responds to the demands of the population.

Artificial Intelligence as a factor of inclusion and promotion of multiculturalism in the preservation of Quechua in Peru

Result 8: The inclusion of Quechua in AI tools can be a factor of inclusion for Quechua speakers in the technological space, promoting the preservation of the language through its teaching. However, more interest is required from technology companies to insert indigenous languages into AI tools.

Discussion of the result 8: AI can promote the inclusion of Quechua speakers and therefore help preserve that language. This can be done by empowering indigenous populations to participate in projects in which their language is included in technology. This would lead to a better appreciation of the culture of these people and would even improve the quality of education because it would be possible to learn in indigenous languages with AI. However, it is currently seen that many technology companies are not interested in adding more indigenous languages or in dialoguing with indigenous populations to include their languages. However, it is indeed necessary to preserve such languages and work with organizations that advocate for the inclusion of indigenous languages and thus curb localization biases; this will allow us to respond to local emergencies in indigenous languages. Regarding this, Interviewee 5 (2024) commented: "It is important for localization organizations to have a voice and influence at the table to convey concerns about AI use to technology developers and ways to improve it."

Similar in opinion to this finding were Soyly & Şahin (2024), who mentioned that technology developers should be involved in the development of AI technologies in indigenous languages. This will also require political support with the participation of indigenous people and educational entities. A clear example of organizations that advocate for the preservation and revitalization of indigenous languages in the digital world is The Language Conservancy, an organization that, in cooperation with linguists and teachers, has developed technological applications that keep such languages alive.

Result 9: Including Quechua in AI tools could foster multiculturalism, and this requires joint work with indigenous populations, collaboration with organizations that promote the design of AI tools that include indigenous languages, and public policies for the inclusion of these languages in technologies such as AI.

Discussion of the result 9: If we work with indigenous populations and organizations that promote the development and translation of AI tools in Quechua and other indigenous languages, of course, AI can promote multiculturalism. The above will be achieved if there are public policies in this regard. For example, Interviewee 4 (2024) stated:

I think we have to make our voices heard, make the voices of these communities heard as much as possible, so that when something is implemented, they are not able to ignore an important part of the population. So, public policies are the way to achieve that.

In addition, indigenous populations must be trained to use AI tools to promote intercultural dialogue and foster the preservation of cultural diversity. In all this, no language will be excluded, while at the same time challenging the dominance of the dominant languages and cultures.

In this regard, Quintero (2020) mentioned that indigenous languages should be included in public policies related to education and technology. At the same time, indigenous communities must be involved so that they cooperate in the design and use of technologies in their languages. This is important to prevent the disappearance of these languages and to preserve the worldviews and cultures that have often been silenced. On the other hand, Bernal Camargo & Murillo Paredes (2016) found that in Latin America, there is a need for an appropriation of technologies that is not reduced to mere entertainment, but that serves as a tool for progress, particularly for populations classified as marginalized and relegated.

4. Conclusions

First: Quechua is a vital language, and its preservation is necessary as an element of conservation of the national identity of Peru. In addition, with new technologies, people are taking charge of spreading this language, contrary to previous years when there was a lot of discrimination for using Quechua. Likewise, it should be noted that at the state level, there are laws and public policies that are not very efficient in including Quechua in technologies, and at the private level, there is little specialization in developing content in Quechua.

Second: Although the Peruvian State has carried out projects and programs in technologies that help to spread and learn Quechua, such actions have not been the most optimal. The main problems of the above have been that when this content is developed, it is done without the participation of the Quechua-speaking population and experts in the language. Additionally, the projects that are done in Quechua are not usually attractive or dynamic for learning the language. Meanwhile, in the development of AI tools in Quechua, no concrete actions have been found by the Peruvian Government to include this language in this technology. Therefore, the State should also rely on the private sector to carry out collaboration and create AI tools that spread Quechua.

Third: It is necessary to create AI tools that include Quechua, since, in this way, the language could be preserved. By implementing AI tools with Quechua content, the Peruvian Government would encourage the language to be transmitted from generation to generation.

Fourth: With the implementation of AI tools in Quechua, non-Quechua speakers could learn Quechua, while Quechua speakers could reinforce their language and thus transmit and teach it. However, there are

difficulties in potentially using this technology if the problems that Peru has regarding the digital divide, the scarce development of Quechua content in technologies, and the lack of participation of the Quechua-speaking population in the development of AI technologies in Quechua are not solved.

Fifth: Developing AI technology in Quechua would encourage the inclusion of Quechua-speaking people, making them feel included and empowered. Likewise, it would promote multiculturalism because by including Quechua in AI tools, it would be shown that all cultures, including the Andean one, are important.

Six: Although AI tools are being used in the localization sector to help translate applications or programs into various languages, in the case of those considered minority languages, this still presents limitations. For example, there are no AI tools that fully understand the social and cultural contexts of such languages, because linguistic resources are scarce.

Seven: If AI tools are to be created that contain content in Quechua, the participation of Quechua speakers must be included to validate that content. What's more, the participation of the Quechua-speaking population must be encouraged because it is their knowledge that will be incorporated into a digital tool, so the ownership of indigenous data must be protected. In addition, it would be necessary for localizers to also participate in making corrections and validations of AI tools that contain languages such as Quechua, due to the level of specialization that these people have.

Eight: If good AI tools are developed that include information in Quechua, people can learn the language. However, it is necessary for the technology companies that create these digital tools to commit to incorporating minority languages. This is essential because having AI tools with content in Quechua will encourage learning the language, and the Quechua-speaking population to feel represented. To achieve this, it is also necessary to work with organizations that advocate for linguistic rights and for localizing minority languages. Likewise, public policies are required that encourage the inclusion of Quechua in AI tools.

Nine: The integration of AI into the preservation and revitalization of Indigenous languages, such as Quechua, represents a significant opportunity, but it also poses complex challenges that extend beyond the technological realm. While AI can facilitate documentation, translation, and teaching, its effectiveness depends on the availability and quality of data, the suitability of the tokenizers, and the inclusion of dialectal variations. Without these elements, the system risks producing inaccurate translations and distorted cultural representations.

Ten: Beyond the technical aspects, linguistic revitalization demands a culturally sensitive approach that respects the worldview of the communities and guarantees their active participation in the design of the tools. AI cannot replace social interaction or public policies that ensure the sustainability of languages in their natural environments. Furthermore, the global dimension of Quechua, evidenced by its presence in diasporas and digital spaces, requires transnational strategies that acknowledge its diversity and avoid extractive practices.

Eleven: Machine translation and localization are processes that involve political and ethical decisions. For AI to truly contribute to linguistic preservation, it must be developed in cooperation with native speakers and translators, guaranteeing informed consent, data sovereignty, and respect for cultural diversity. In short, revitalization should not be measured by the number of applications created, but by their capacity to empower communities, strengthen community use, and maintain the social bonds that sustain the life of the languages.

5. Data availability

The data supporting this study's findings are available in the article. URLs are available in the references section.

6. Declaration of contribution by authorship

The conceptualization, methodology, software, validation, formal analysis, research, resources, data curation, writing – original draft, writing – review and editing, visualization, supervision, and administration of the project were carried out by Brenda Isabel Murrugarra Retamozo.

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