



Speaking for Sustainability: AI-Driven Language Technologies in Achieving the SDGs

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ARTICLE INFO			ABSTRACT
Article History:			<i>This study explores how AI driven language technologies can promote the United Nations Sustainable Development Goals (SDGs). Using a multi-method approach a systematic literature review, interviews with experts and case study analysis. It showed how natural language processing (NLP), machine translation and conversational AI are transforming the ways we communicate, access and include in sustainable development contexts. The research also highlights that these technologies greatly expand multilingual access to education, healthcare and civic participation, most especially for marginalized and linguistically diverse population groups. But there are still problems algorithmic bias, environmental cost and languages of low resources all excluded. However, the study also underlines the need for ethical governance in developing AI for development because, as the study shows, it is already meeting many of its design failures, some of which could have major consequences. Finally, it concludes that the integration of AI language tools would need to be context aware and grounded in the local context to succeed. Policy recommendations for developing inclusive AI ecosystems, promoting digital literacy and embedding environmental and ethical considerations in AI innovation are offered by the research. This study underscores how to rethink about language as a key infrastructure for sustainable futures and to move toward the communicative equity of our global AI deployments.</i>
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Introduction

The transmission of knowledge, the formation of policy, cultural exchange and global cooperation are all central to language. As communication across linguistic and cultural boundaries becomes

more and more necessary to face common global challenges in an ever more interconnected world, effective communication in more than one language has become critical. The United Nations set of Sustainable Development Goals, adopted in 2015, are all encompassing outlines to end extreme poverty, assure mutual progress, protect our planet and create inclusive institutions [1]. Yet those goals cannot be achieved on infrastructure, technological and economic solutions alone. It also needs inclusive accessible and multilingual communication systems that can empower people and communities [2]. The rise of artificial intelligence (AI) is concretely translating into new ways to promote dialogue worldwide and to provide access to knowledge through language technologies such as natural language processing (NLP), machine translation, speech recognition and conversational agent [3]. These AI driven tools can enable improved dissemination of important information, amplification of marginalized voices and participation in decision-making processes in multilingual and low resource settings, to support sustainability efforts [4].

However, the communicative functions of language technologies with reference to development and governing sustainable organizations have not yet been researched [5,6]. While most of the existing research pertains to contributions of AI in sectors such as health, agriculture and infrastructure, there has been little coverage on language specific AI deployments that can immediately affect the implementation and monitoring of the SDGs [7]. But AI powered language technology can fill the gaps to deliver the much-needed education, health communication, disaster response, environmental awareness and civic engagement which by their nature depend on quality and inclusive communication [8]. Additionally, these tools enable scalability for translating policy documents, community outreach, automating sustainability reporting and analyzing public commentary on sustainability topics [9]. However, algorithmic bias, data ownership, linguistic exclusion and digital inequality are still significant challenges, also. Training of many AI models continues to play out mainly on data from mainstream world languages, as this can marginalize communities speaking a minority language and perpetuate digital divides. Moreover, using these technologies to achieve environmentally oriented goals is reversible in and of itself, at the cost of environmental costs to train large language models. This study is therefore focused on making sure that AI-based language systems are deployed in an ethical, socially inclusive and essentially sustainable way.

The main aim of this study is to critically assess the promise of AI driven language technologies for advancing Sustainable Development Goals through the investigation of their current applications, investigation of socio technical issues and opportunities in their potential deployment and by developing a conceptual understanding of their contribution to inclusive, effective and sustainable communication across different development contexts. To address this aim, the study uses a qualitative and explorative approach and utilizes literature review, thematic analysis and expert interviews. Real world implementation and context challenges are then illustrated through selected case studies from community based and international initiatives. By taking this approach, this study is part of a growing interdisciplinary literature that straddles the boundaries of linguistics, AI and development and that contributes both to theory and practice of stakeholders aiming to take advantage of the communicative potential of AI for a more equitable and sustainable future.

Materials and Methods

To comply with the main objective of this study which is to critically explore the prospect of AI-driven language technology for achieving the SDGs by evaluating their applications, socio technical issues and a role in inclusive and sustainable communication, a qualitative, exploratory and interpretivist approach has been adopted. The complex, interdisciplinary nature of the study justifies this methodological orientation because it draws from the fields of artificial intelligence,

linguistics, sustainable development, as well as information ethics [8]. As well as documenting the current use of AI based language systems in the SDG context, the study aims also to examine how these technologies are situated in socio cultural, political and institutional environments. Accordingly, the materials and methods are organised into three central elements: (1) a critical and integrative literature review, (2) qualitative interviews with domain experts and (3) comparative case studies of existing applications.

Critical Literature Review

The first part of the research entailed a critical and integrative review on scholarly and grey literature. We attempted to trace prevailing narratives and conceptual frameworks, methodological approaches and the gaps on the discourse around AI language technologies and their connection to the SDGs. Within major academic databases such as Scopus, Web of Science, JSTOR, IEEE Xplore and Google Scholar key words including ‘AI and SDGs’, ‘natural language processing for sustainability’, ‘machine translated for development’ and ‘language technologies for inclusion’ are searched. In total over 150 sources were reviewed, including peer reviewed journal articles, white papers policy briefs and industry reports published between 2015-2024. However, unlike traditional literature reviews, this stage used thematic content analysis and discourse mapping to synthesize not only empirical findings, but also the normative orientations entrained in the literature. The underlying assumptions regarding technology's neutrality, the visibility of linguistic diversity and the level at which sustainability is staged as communicative as well as material challenge, received special attention. The theoretical and analytical basis for the subsequent stages of this research was based on this review.

Semi-Structured Expert Interviews

To move beyond textual data and to employ contextual and operational knowledge to unpack the contextual and operational dynamics of AI driven language technologies, the study conducted semi structured interviews with experts from academia, international organizations, AI development firms and civil society institutions. Individuals with practical or scholarly involvement at the point of contact between language technologies and sustainable development were purposively sampled. 18 interviews were conducted over a period lasting between 45 and 75 minutes. Our interview protocol was designed to elicit both descriptive and analytical information; to elicit descriptive information, the interview protocol included questions about (1) what kind of language technologies are in use in SDG-related projects, (2) where they are being used in socio-linguistic and infrastructural terms, (3) what are perceived opportunities, risks such as algorithmic bias, (4) accessibility and inclusion in the language translation and (4) what are the institutional and ethical frameworks around the implementation framework. Interview data was transcribed verbatim and data was then analyzed based on constructivist grounded theory principles. NVivo 14 software was used to code which involved multiple cycling between initial open coding to axially code categories; and selective coding to construct thematic narratives that align with the study aim.

Comparative Case Study Analysis

The third methodological pillar was comparative case study analysis of selected initiatives utilising AI language technologies in service of the SDGs. Case selection was criterion based and purposeful sampling to represent geographies, linguistic diversity, types of development sectors and types of technology. In depth, three core cases were examined: A multilingual machine translation platform applied on delivery of educational content in Sub-Saharan Africa, aligned with SDG 4: Quality education. Maternal healthcare awareness voice chatbot deployed in rural South Asia (Matcher with SDG 3: Good Health and Wellbeing). An NLP based community led civic

engagement tool used for local governance in Latin America (SDG aligned 16: Peace, Justice and Strong Institutions). We analyzed technical documentation, user reports, project evaluations and where possible follow up interviews with project stakeholders for each case. Socio technological systems theory which argues that technology and society are co constructed was drawn on to inform the analytical framework from which case studies were interpreted. It enabled us to assess not only technology affordances but also the institutional, cultural and political environments in which these technologies function.

Analytical Framework and Ethical Considerations

A meta thematic synthesis of the findings across the three research components literature, interviews and case studies was conducted to triangulate findings. By following this method, convergence and divergence analysis of emergent themes were possible to include analytical depth and credibility. Linguistic accessibility and equity, governance for AI tools, sustainability metrics for language technologies and ethical implications from large scale language model deployment in low resource settings were identified as key categories. Throughout the study ethical integrity was maintained in accordance with institutional review protocols. All interview participants gave informed consent. Data were anonymized, confidentiality maintained, and cultural sensitivities considered particularly when discussing technologies being deployed in underrepresented or indigenous communities.

This study's results clarify the ways in which these AI-driven language technologies are being practically applied, how well they (and the more limited aspects of research discussed) align with the SDGs and what socio technical challenges assist and hinder effectiveness [6,10]. Through thematic synthesis we identified three overarching themes: (1) enabling inclusive communication for development, (2) technological affordances and limitations and (3) ethical and institutional considerations for sustainable deployment. Next, below we discuss these themes using both critical interpretation and integrated insights from empirical data.

1. Enabling Inclusive Communication for Development

Across all the literature, interviews and case studies where we look at these differing language platforms, research finds one of the most consistent findings is the transformative way in which AI language technologies have bridged linguistic divides to expand inclusion in communication [11]. In the context of tools like neural machine translation (NMT), speech-to-text systems and voice-based assistants, marginalized populations (low literacy and non-dominant language speakers) have benefited from improved access to information. For example, the African education focused case study describes how open-source translation platform successfully localized the primary school curricula to the regional languages. Interviewees commented that such tools find use in helping cultural continuity while providing other pedagogically beneficial tools, all of which ultimately translate to SDG 4 (Quality Education). A chatbot tasked with offering maternal healthcare information in Urdu, Hindi and Tamil also showed its outreach among rural women that had not been able to receive reliable medical advice before [12]. The findings in this dissertation underscore the importance of language as infrastructure or not as a tool for interaction but rather as a requirement for equitable participation in development processes. Though interviewees stressed that linguistic accessibility is not merely translation, the current AI systems are unable to achieve context specific language modelling so far. Many NLP models aren't trained in languages that are rich in dialect or low resource and so reproduce linguistic hierarchies, several experts observed [6,11,13]. Concern was especially palpable in Latin America, where commercial NLP systems did not recognize indigenous languages and syntax very well and therefore civic participation platforms made relatively little impact on indigenous populations.

2. Technological Affordances and Limitations

There is real potential for AI driven language systems to automate tasks like sustainability reporting, citizen feedback analysis and policy translation. We describe several such applications of our work in existing cases, from the translation of responses to a presidential candidate in international development forums to sentiment analysis tools for public opinion surveying of their responses to environmental policies (SDG 13: Climate Action) [8,14]. An international NGO interviewed uses multilingual text analytics to monitor misinformation about COVID-19 vaccines in low-income regions with a view to being able to correct these quickly and communicate to target areas based on the content of the messages an application that also meets SDG3 (Good Health and Wellbeing). Nevertheless, limitations of a technical and infrastructural kind are identified as major obstacles to sustainable deployment. Firstly, since AI language models data dependent, access to high digital footprint languages continue to benefit while their use in low resource linguistic contexts remains inaccessible. Second, AI developers expressed serious concerns about the computational demands and thus environmental costs, associated with training large language models (LLMs). In opposition to the sustainable development objectives for 2030, SDG 12: Responsible Consumption and Production, one participant noted that training a single LMM consumes more energy than many hundred households per year [4,8]. Additionally, generative models of this type suffer from semantic drift and hallucination, where AI systems generate plausible but factually incorrect outputs, with high risks to the health and safety of members of the population, in particularly critical domains such as health care, climate policy and legal interpretation. It introduces new epistemic vulnerabilities to development communication that will undermine trust and inclusivity, if not addressed.

3. Ethical and Institutional Considerations

The study also uncovers a dramatic governance and ethical oversight gap for use of AI language systems in development settings [5]. However, as developers often highlight that efficiency and scalability are their main export, many interviewees from NGOs and academia expressed intervention on ethical and weaker on language justice and transparency or fairness. Without community consultation in many AI deployment processes, we end up with solutions that are highly technically sophisticated and, ultimately, poorly socially aligned. Analysis of case studies showed that the projects with the greatest impact were those in which human centred design was adopted at the front end (with input from local language experts, hybrid human AI workflows and community feedback on iterations) [2]. To take one example, the success of the Latin American civic tech initiative was attributed to the participation of community linguists, who would train the AI system in underrepresented dialects. These AI tools are dropped in as opposed to more participatory approaches that adapt the social and linguistic environment to fit the tools. Additionally, in those digital rights weakened areas, there was concern over a person's data ownership, surveillance and consent. If unattested information is collected by unmonitored AI chatbots for hot topics like reproductive health or civic activism, users will be exposed to the associated risks while the humans are blissfully unaware. As a result, ethics by design principles, as well as regulatory frameworks which balance global standards and local reality, became the focus of a key development area.

Conclusion and Recommendations

This study critically analyses the nexus of AI driven language technologies and Sustainable Development Goals (SDGs), highlighting the potential of these technologies for furthering the global development objectives as well as the complexities they introduce in this endeavor. The research which takes a multi-method approach of systematic literature review, expert interviews

and detailed case studies, shows that by leveraging AI language tools can significantly improve inclusivity, sharing of knowledge and multilingual engagement across multiple sustainability domains. From improving access to healthcare information in rural areas, delivering localized educational content and supporting civic participation, these tools have great potential to directly contribute towards realizing Quality Education (SDG 4), Good Health and Wellbeing (SDG 3), Gender Equality (SDG 5) etc. and Climate Action (SDG 13).

But the study also points to several critical challenges to be addressed to reap this potential profitably and sustainably and fairly. These include biases of language models that undermine the support for low resource languages and dialects, the large environmental footprint during training of large-scale AI models and a lack of holistic ethical frameworks for deployment of AI in vulnerable communities. Taken together, these findings illustrate a need to go beyond purely technical solutions towards a more honest understanding of what any new solution must take into consideration: such solutions will need to be human centered with a focus on ethical inputs and situated with respect to culture and local context. Theoretically, this research is a contribution to the corpus of critical AI and sustainability studies by pointing out the function of language as simultaneously a technological and socio-political infrastructure. From a practical perspective, it reveals the foundations for formulating more inclusive AI design principles but also offers insights into participatory methodologies that import local knowledge and linguistic diversity into AI development. Several policy recommendations come out of these findings. At a first level, linguistic inclusion should be acknowledged as a core constituent of sustainable development, dedicating more support to natural language processing research on lesser studied languages, especially in areas in which language barriers set out against social inequalities. Second, global AI ethics frameworks need to be made locally adaptable, through stakeholder inclusive engagement and participatory governance, making them transparent, ensuring data protection and cultural sensitivity. One last phase should enhance the integration of strategic AI language technologies into national SDG implementation plans in a way that promotes areas including public health communication, educational reform, disaster response and civic engagement.

In addition, much of this work entails developing strong partnerships among governments, private sector actors, academia and civil society in developing contextually appropriate and scalable language solutions together. Digital and linguistic literacy within local communities is also crucial, as local communities would otherwise become excluded from software products or face new forms of digital exclusion if they are unable to interact effectively with AI tools. Finally, because of the environmental impact of large language models, sustainable assessments of these developments should become the standard practice in AI development, in addition to providing incentives for adopting energy and computing efficient technologies and practices. In short, the technological sophistication of AI language technology will be insufficient to help achieve the SDGs, without also guaranteeing linguistic justice, participatory design and sustainable governance. By framing the communicative dimensions of development at the center and operating an inclusive view of human language, policymakers and developers can create AI systems that enable sustainability with equity.

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