Review

Digital Language Services: Evolution, Challenges, Opportunities, and Ethical Implications

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ABSTRACT

Digital language services (DLS), powered by advanced technologies, have become effective instruments for promoting cooperation and communication across linguistic boundaries. We selected 25 publications to guide this study based on both inclusion and exclusion criteria. Through a systematic review based on the framework of PRISMA, it is revealed that there is a huge potential for innovation and progress in the intelligent language service industry, even while there are still difficulties and ethical concerns unaddressed. We can fully utilize DLS to construct and maintain a more interconnected and inclusive world by tackling these obstacles and utilizing cutting-edge technologies. The collaboration between humans and technologies also plays an important role in DLS. It is expected that humans will improve the development of DLS by assisting with technologies rather than replacing them. This study formulates a solid foundation for future researchers and practitioners, based on which numerous research directions can be delved into shortly. The findings can be applied to various fields such as education, marketing, social studies, and computer science.

Keywords: Digital Language Services; Evolution; Challenges; Opportunities; Ethical Implications

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1. Introduction

1.1. Definition of Digital Language Services

Digital language services (DLS) can be defined as language service providers that incorporate advanced artificial intelligence (AI) and machine learning (ML) technologies into the provision of language services [1] These services include automated and semi-automated processes that improve language-related tasks' effectiveness, precision, and customization, including translation, interpretation, localization, speech recognition, natural language processing (NLP), and text analytics. AI algorithms are used by DLS to understand, analyze, and generate human language content in multiple languages; these systems are often able to adapt and improve with time through exposure to additional data [2]. DLS enables smooth communication across linguistic and cultural barriers, allowing multinational corporations, organizations, and individuals to engage productively in a multilingual world.

1.2. Key features of Digital Language Services

Integrating AI technologies into traditional language services can endow several key features with DLS. The key features include automated translation, recommendation [3], and localization. DLS could provide highly efficient services through neural networks and deep learning techniques, which could help humans translate many texts or multimedia sources into target languages. Speech-to-text and text-to-speech conversion can be easily realized through machine learning techniques. Natural language processing can help humans understand the depth of language nuances, conduct sentimental analyses, and create advanced tools such as chatbots and virtual language assistants. DLS can tailor their services to the diverse needs of customers by personalizing interfaces and enhancing users' experiences. AI technologies in DLS can report learning behaviors, correct linguistic errors, and provide suggestions for language outputs to improve continuous education. Generally, DLS can provide a platform to integrate AI technologies into traditional language services, break down linguistic barriers, and accelerate the development of the language service industry.

1.3. Importance of Research on Digital Language Services

In an increasingly globalized world, the ability to communicate effectively across different languages is of great importance. Technologies in DLS have emerged as powerful tools to bridge the gaps caused by incomprehensible languages, facilitating international trade by providing high-quality language services, improving cultural exchanges through language education, and enhancing global collaboration through international communication [4]. Language services, e.g., interpretation, translation, language education, localized services, language testing, and assessment [5], can undoubtedly facilitate cross-cultural communication and increase international trade, leading to positive prediction of the impact of language services on economic development and cross-cultural communication. Therefore, this paper aims to comprehensively explore DLS's evolution, challenges, and opportunities.

2. Methods

This study keeps in line with the reporting guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) formulated in 2020. PRISMA provides useful and specific guidelines for reporting a systematic review pivoting on a certain topic, which consists of PRISMA 2020 checklist, PRISMA 2020 flow diagram, PRISMA 2020 statement paper, PRISMA 2020 Explanation and Elaboration paper, and Citing and using PRISMA 2020. This study aligns with the PRISMA 2020 checklist which includes 27 items describing guidelines for writing introduction, methods, results, and discussion in an academic paper [6], as well as other requirements specified in PRISMA 2020.

3. Literature Search

To gain enough data for the analysis, we searched multiple online databases including Web of Science, Scopus, Springer Link, on September 22, 2024. We obtained 59

results from All Databases for: "language service*" (Topic) and intelligen* (Topic), refined by: NOT Database: Preprint Citation Index in Web of Science, ranging from 1992 to 2024. By entering "language service*" AND intelligen* (title/abstract/keywords) into the search column in Scopus, we obtained 64 results, ranging from 1994 to 2024. The main publication titles included Journal of Physics Conference Series, Cognitive Technologies, Lecture Notes in Computer Science, Communications in Computer and Information Science, and Lecture Notes in Electrical Engineering. We obtained 378 results by entering intelligen* AND "language* service*" into the search column in Springer Link, ranging from 1979 to 2024. We obtained 20 results by entering language service AND intelligent into CNKI, ranging from 2018 to 2024 and including numerous disciplines such as Chinese language and literature, foreign language and literature, computer science, information economics, education, etc.

We established both inclusion and exclusion criteria to filter and select the literature used for guiding this study. We would include the literature if they (1) fell in the scope of DLS, (2) were of high quality based on the criteria established by the American Research Educational Association (AREA), (3) were rigidly designed and arrived at convincing conclusions, (4) were well structured and written in satisfactory languages, or (5) adopted an adequate sample size and proper sampling strategies. We would exclude the literature if they (1) were not in the scope of DLS or focused on computer sciences, (2) were poorly designed or of lower quality based on AREA criteria, or (3) failed to provide enough data to conduct this study. After filtering the literature based on the inclusion and exclusion criteria, we selected 25 publications to guide this study (See **Table 1** for details).

Table 1. Details of included studies.

N	Author	Year	Source	Major Findings
1	Alrawashdeh et al	2024	Educational Research Review	A small effect of personalized and adaptive learning technologies was found on reading literacy.
2	Ameri & Ghahari	2018	Interpreter and Translator Trainer	A motivational protocol in translation training was established.
3	Ameur et al	2019	Machine Translation	Arabic neural machine translation could be improved through n-best list re-ranking.
4	Camara-Arenas et al	2023	Language Learning & Technology	Google automatic speech recognition failed to meet the conditions for the automatic pronunciation assessment system.
5	Chen	2023	Soft Computing	The integrated mode is effective in international trade teaching.
6	Chung & Yeol	2012	Journal of Product Research	Advanced technologies could improve the quality of language education services.
7	Clarke et al	2002	Machine Translation: From Research to Real Users	Machine translation plays an important role in commercial environments.
8	de Moissac et al	2020	Healthcare Management Forum	The use of DLS technologies in healthcare could improve the life quality of patients and improve management strategies.
9	Divya & Hema	2021	Literary Voice	Deep learning should enable personalized learning.
10	Eunice & Hemanth	2022	F. Ortiz-Rodrguez et al (Eds.), EGETC 2022	Deep learning can improve the performance and versatility of language services.
11	Fang	2024	IEEE Access	DLS can greatly cater the services to the needs of diverse customers.
12	Farzi & Faili	2015	Computer Speech and Language	Statistical and example-based techniques replaced rule-based systems.
13	Fu et al	2020	Acoustical Science and Technology	DLS models can learn complex patterns, enabling accurate translations, speech recognition, and language understanding.
14	Han	2022	International Journal of Multilingualism	Accurately interpreting language in context remains a challenge.
15	Hsu	2024	Innovation in Language Learning and Teaching	Technologies used in DLS should be developed and deployed responsibly and equitably.
16	Hu & Wu	2020	System	DLS struggles with idioms, sarcasm, or cultural references.

17	Kim	2023	Interactive Learning Environments	Misuse of DLS raises privacy and security concerns.
18	Li	2020	Doctoral dissertation for University of Wisconsin-Madison	DLS can facilitate cross-cultural understanding and collaboration, fostering global connectivity.
19	Li et al	2024	Entertainment Computing	The capabilities and quality of DLS can be greatly improved powered by innovative technologies.
20	Moore et al	2021	Big Data and Cognitive Computing	The inadequate or imbalanced training data may introduce bias or under-representation into the DLS systems.
21	Pokorn & Juznic	2020	Translation and Interpreting Studies	It is crucial to consider ethical implications in DLS.
22	Susoy	2023	Doctoral dissertation for Anadolu University	The complexity and diversity of human languages continue to pose challenges for the development of DLS.
23	Tour et al	2024	Language and Education	Learners in diverse classrooms can express themselves and facilitate cross-cultural communication.
24	Tsai	2022	Computer Assisted Language Learning	AI-assisted translation can improve translation services.
25	Weng et al	2024	Mathematics	Ethical issues should be considered in data corpus construction.

As shown in **Table 1**, we selected the publications comprehensively and inclusively to represent the whole population. The documents we selected included journal articles, conference proceedings, and doctoral dissertations, most of which were sourced from high-quality journals. The periods were also widely distributed, ranging from 2002 to 2024. The publications vary in research methods including systematic reviews, experimental studies, quasi-experimental studies, case studies, etc. The included studies mainly focus on DLS, advanced technologies for language services, and AI algorithms for language services, comprehensively exploring language services from the perspective of AI technologies. The authors came from various countries and areas across the world, reducing the geographical bias. The sample size is large enough to carry out a systematic review study aiming to investigate a promising topic, i.e., DLS services.

4. Results and Discussion

4.1. Evolution of DLS

4.1.1. Historical Background

When the initial generation of machine translation tools developed around rule-based systems in the 1950s, machine translation played a significant role in DLS and commercial environments [7]. During this time, computer programs that encoded language rules and electronic dictionaries were major sources of assistance for machine translation [8]. These systems were intended to generate translations by using linguistic norms to guarantee grammatical accuracy and coherence and accessing dictionaries for word-for-word replacements. The synonyms and antonyms were carefully considered before the outputs were presented. Although this method was a major advancement in automating the translation process, it was constrained by its incapacity to manage the subtleties and complexity of natural language.

Rule-based systems began to give way to statistical and example-based techniques as technology developed [9]. These more recent techniques made use of the abundance of text data available to train machine translation systems. These systems have the potential to generate translations that are more adaptable and context-sensitive by examining the statistical patterns and frequency of words, phrases, sentences, or discourses in translated texts. This breakthrough allowed translation systems to offer not only literal translations but also words and idiom recommendations derived from usage analysis. In this stage, cultural and emotional factors have begun to be important elements in the assessment of translation although they cannot be fully addressed yet.

Machine translation underwent a revolution with the introduction of statistical and example-based techniques, which paved the way for the creation of increasingly complex and precise translation systems. These systems could evaluate the translated terms and provide the best options for different users, such as teachers, language learners,

designers, and translators. These systems aided in language learning and comprehension by offering instances and frequency of word entry and coinages, making them useful resources for a variety of users. Cultural differences and emotions even metaphors could be considered in the process of provision of accurate translation. The new generation of AI technologies such as ChatGPT has greatly promoted the quality of machine translation by integrating emotions, cultures, figures of speech, and other factors.

4.1.2. The Rise of Deep Learning

The advent of deep learning, particularly transformer-based models, has revolutionized DLS. These models can learn complex patterns in language data, enabling more accurate and nuanced translations, speech recognition, and language understanding [10]. With a growing amount of input, the models can be increasingly optimal and more powerful in language understanding and translation. Thus, the quality of language translation and communication improves, leading to more accurate comprehension of various language speakers and smoother cross-cultural communication. This can improve language services and facilitate the development of digital and intelligent technologies used for language services. The integration of deep learning into DLS has led to significant improvements in the performance and versatility of language services [11]. The intelligent algorithms used in deep learning can improve the translation quality and shorten the response periods.

Deep learning has brought great changes to DLS and promoted machine translation by increasing accuracy and efficiency. Deep learning has integrated machine translation, speech recognition, and natural language processing into the process of translation, enabling more accurate and effective results. Deep learning models, combining DLS tools such as chatbots, ChatGPT, and virtual translators, greatly facilitate translation competence and promote communication between people with diverse backgrounds. Deep learning realized personalized learning by providing learning resources according to the diverse needs of different learners [12]. It also greatly increased the number of source texts to be translated in a shorter period compared with traditional machine

translation methods. Despite ethical concerns such as data privacy and social security, deep learning can undoubtedly promote the quality of DLS, enhance the innovation of DLS, and improve the experiences of users.

4.1.3. Integration with Other Technologies

DLS has also gained popularity by integrating advanced technologies such as speech synthesis, chatbots, and virtual assistants into language services [13]. Integrated into speech synthesis technologies, DLS can be greatly improved in terms of feedback period, accuracy, and comprehension of human speech and talk. Intelligent translation machines can provide feedback within a shorter time due to the rapid processing of speech analyses. Digital and intelligent chatbots can also provide more accurate and rapid responses to human questions or inquiries via the integration of DLS into chatbots. Virtual assistants can replace part of human tasks such as pedagogical agents and language robots and greatly improve the quality and quantity of DLS although it may be hard for them to completely replace humans. In general, these integrations have broadened the scope of language services, enabling more interactive and natural communication experiences.

The capabilities and quality of DLS can be greatly improved powered by innovative technologies such as natural language processing, machine learning algorithms, artificial intelligence, and chatbots [14]. Integrated into these technologies, different source languages can be translated into target languages accurately and efficiently, leading to enhanced cross-cultural communication and inter-disciplinary cooperation. Further integration into speech recognition technologies could enhance voice recognition [13], feedback timeliness, and correction efficiency, thus garnering the effectiveness and quality of DLS. Furthermore, by leveraging AI technologies, DLS can greatly cater the services to the needs of diverse customers by detecting sentimental changes and conducting in-depth sentimental analyses [15], which can provide constructive recommendations for DLS providers and designers. One important component, AI chatbots, can provide continuous services and offer high-quality support for various kinds of customers, facilitating international transactions and business operations. The combination with blockchain technologies

should enable DLS to provide secure and transparent business trade and bolster mutual trust in mutual interactions.

4.2. Current Challenges

4.2.1. Language Complexity and Diversity

Despite progress, the complexity and diversity of human languages continue to pose challenges for DLS [16]. Some languages, particularly those with non-Latin scripts or rich morphological systems, remain difficult to process accurately and efficiently. It may thus pose a threat for humans to communicate with each other, which will exacerbate the quality of language services, produce barriers to cross-cultural communication, and reduce the productivity of the language industry. Other languages with complex grammatical rules, e.g. German and Spanish languages, may pose a great challenge for algorithms to process accurately and effectively. The quality of DLS, as well as the efficiency and effectiveness of DLS, may be poor due to the complexity of grammar and difficulty in processing.

4.2.2. Contextual Understanding

Contexts may bring about much trouble to DLS in terms of contexts, idioms, sarcasm, and cultural differences. On one hand, accurately interpreting language in context, particularly in informal or domain-specific settings, remains a challenge [17]. When confronted with this challenge, interpreters can use digital and intelligent tools to help them understand and interpret accurately. This is one of the rationales for the facilitation of the development of DLS in the new information age. On the other hand, DLS often struggle with idioms, sarcasm, or cultural references which are crucial for effective communication in different contexts [18]. Due to prominent differences in various cultures, there may be various kinds of idioms, sarcasm, or cultural references, which may greatly increase the difficulty in providing accurate interpretation or translation promptly. Interpreters and translators may need to seek assistance in understanding the terms in various contexts, which can weaken the quality of DLS.

4.2.3. Data Bias and Fairness

The performance of DLS is heavily dependent on the training data used to develop them. Imbalances in data across languages and domains can introduce biases into systems, affecting their fairness, accuracy, and inclusiveness [19]. The limited scope of training data may mislead algorithms and cause defects in the outcomes produced through technologies, leading to misinterpretation of or wrong responses to the questions raised by humans. The inadequate or imbalanced training data may introduce bias or under-representation into the DLS systems, which may cause inaccuracy in predicting acquisition and retention of knowledge [20]. The biases or under-representation may result in comprehensively negative consequences, weakening the inclusiveness, accuracy, and fairness of the analysis results, which may lower the quality of DLS. The inadequate data of minor languages may also introduce biases in the interpretation of them, causing biases or misunderstandings of them, as well as negative effects on DLS. Researchers and developers should attach great importance to the representation and inclusiveness of training data to improve the quality and quantity of DLS.

4.2.4. Privacy and Security

The processing of sensitive personal information and the potential for misuse of DLS raise privacy and security concerns, which is similar to online learning [21]. Privacy may be revealed or even spread if carelessly handled, which may cause security concerns as a result. The public may lose confidence in the use of DLS and feel resistant to it, which may hinder the development of DLS. Ensuring data protection and mitigating the risks of malicious applications is essential for public trust and widespread adoption. Researchers and designers should pay special attention to the issue and take effective measures to promote the development of DLS according to correct and proper directions. They should also take reasonable precautions to address emergency issues and protect the victims. Only in this way can DLS develop in positive directions and improve the quality of language services in the digital and intelligent age.

4.3. Emerging Opportunities

4.3.1. Enhanced User Experience

Continuous innovations in DLS will be able to enhance more intuitive, adaptive, and personalized user ex-

periences [22]. Enough training in language data should enable intelligent systems to produce nearly intuitive responses to linguistic questions. The analysis of learning behaviors and habits can provide hints for systems to create adaptive questions or responses, improving adaptive learning effectiveness. The intelligent systems can then provide proper learning suggestions or designs for learners to facilitate their learning progress and improve their learning outcomes. Systems can also provide personalized learning resources for learners to realize personalized learning and enhance the impact of DLS on language acquisition and retention [12]. Systems that can understand and respond to user emotions or preferences promptly will enhance the quality of cross-lingual communication.

4.3.2. Multilingual and Multimodal Integration

The integration of multiple languages and modalities (e.g., text, speech, vision) into DLS will enable more natural and seamless communication experiences. This will facilitate cross-cultural understanding and collaboration, fostering global connectivity [23]. With multiple languages integrated into DLS systems, speakers of various languages can communicate with each other assisted by intelligent translators or interpreters. With multiple modes of language inputs and outputs, learners in diverse classrooms can express their meanings and understand others' languages, facilitating mutual understanding among diverse groups of people [24]. DLS speech recognition technologies can immediately understand speeches in the modes of various languages and transfer the meanings in forms that can be understood by people with diverse backgrounds. Able to understand and translate multimodal languages, DLS helps people to communicate with counterparts with various backgrounds and facilitates communication among different countries and areas.

4.3.3. Industry Applications

DLS technologies have vast potential for application across various industries, including healthcare, education, customer service, and e-commerce. These technologies can streamline workflows, improve efficiency, and enhance customer satisfaction. The use of DLS technologies in healthcare could improve the life quality of patients

and improve management strategies [25]. DLS technologies could provide personalized education by offering a large number of reading resources according to the requests of learners, leading to better reading literacy and experiences [22]. DLS technologies could produce human-like greetings such as polite and comfortable speaking and reasonable choices of language, which may improve the feelings of customers and enhance their shopping experiences. Integrated into high-tech equipment such as social media and mobile phones, DLS technologies could also be applied to e-commerce, facilitating product transportation and quality of language education services [26].

4.3.4. Collaboration with Humans

The combination of human-AI collaboration models in DLS will maximize the positive impact of DLS on both humans and machines. For example, AI-assisted translation can assist human translators and enhance their translating efficiency, and better the quality of translation services, while editing and refining by humans can improve the adaptability of AI-generated outputs [27]. In this way, the efforts of human translators and machines can provide high-quality language services and facilitate the development of DLS. Another example is the cooperation between humans and AI technologies in interpretation and translation training programs [28]. AI technologies could help humans to understand speeches of various languages rapidly, based on which interpreters could express the meanings and make the speech accurately understood by listeners by integrating cultural factors and contextual meanings. This cooperation between humans and technologies can enhance the accuracy and appropriateness of interpreted texts and speeches.

4.4. Ethical Implications

As DLS becomes more prevalent, it is crucial to consider its ethical implications [29]. Efforts should be made to ensure that the technologies used in DLS are developed and deployed responsibly and equitably, striking a balance between a socially responsible activity and language learning motivation [30]. The technologies in DLS should also be used to complement human abilities rather than replace

them completely. Designers and developers of DLS technologies should make sure they are beneficial to human beings and should not bring harmfulness to humans. Data privacy is another ethical concern in DLS. Data corpus should be constructed in a privacy-preserving multilingual comparable method [31]. Providers of DLS have easy and convenient access to personal data, which may lead them to reveal or manipulate personal data easily. Regulations and laws should be established to prevent and punish this sort of misbehavior. Data security mechanisms should be ensured to prevent illegal, vicious, or unethical access. Biases in algorithms should be minimized to tolerate diverse cultures. DLS providers should assume the social responsibility to sustain the development of human society.

Figure 1 showcases the major findings of this study. This study classified the issue of DLS into four points, i.e. evolution of DLS, current challenges, emerging opportunities, and ethical implications. We examined the evolution of DLS scoping from its historical background, the rise of deep learning, to integration with other technologies. The current challenges facing DLS include language complexity and diversity, privacy and security, data bias and fairness, and contextual understanding. DLS also garner emerging opportunities, i.e. multilingual and multimodal integration, enhanced user experience, industry applications, and collaboration with humans. Finally, we discussed the ethical implications of DLS.
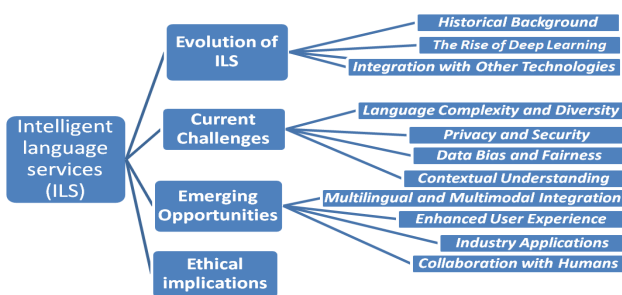

Figure 1. A figure summarizing the findings.

5. Conclusions

5.1. Major Findings

Recently, DLS, powered by advanced technologies, has become an effective instrument for promoting cooperation and communication across linguistic boundaries. There is a huge potential for innovation and progress in this industry, even while there are still difficulties and ethical concerns unaddressed. We can fully utilize DLS to build a more interconnected and inclusive world by tackling these obstacles and utilizing cutting-edge technologies. Similar to English education through collaborative autoethnography [32], the collaboration between humans and technologies also plays an important role in DLS. It is expected that humans will improve the development of DLS by assisting with technologies rather than replacing them.

5.2. Limitations

Although rigidly designed, this study has several limitations. In the first place, due to the rapid development of intelligent algorithms, this study cannot cover all the advanced technologies used in DLS. In the second place, it is hard for this study to include all the aspects of ethical implications and considerations since new ethical issues may emerge with the rapid development and innovation of technologies. In the third place, the literature included in this study is limited and it is impossible to include all of the literature for this systematic review. In the fourth place, the focus on qualitative research methods may cause personal bias, which may fail to comprehensively represent and summarize the previous studies. Finally, it is profitable to delve more deeply into some of the variables that might or might not have come into play in concluding.

5.3. Future Research Directions

This study comprehensively reviews the evolution, challenges, opportunities, and ethical implications of DLS. It formulates a solid foundation for future researchers and practitioners, based on which numerous research directions can be delved into shortly.

Future researchers and practitioners can delve into the development of innovative technologies driving the development of DLS with the assistance of digital technologies [33]. It is indispensable to explore how to design natural language processing algorithms to promote the development of DLS and provide accurate and efficient

DLS. Limitations and incapability in DLS also need to be revealed and minimized to optimize the effect of DLS. Higher-level technologies such as AI-powered translation and interpretation, deep learning, transfer learning, multi-task learning, speech recognition, and sentimental analyses can be examined to improve the quality of DLS in the future.

The investigation of the ethical ramifications of DLS is a crucial field for future fields such as translation and interpretation [34]. It is critical to take into account the advantages and disadvantages of these services as they grow increasingly ingrained in our every-day lives. Researchers and practitioners may investigate ethical concerns including confidentiality, prejudice, privacy, personal information protection, and responsibility, and devise plans to reduce or minimize the adverse effects of these offerings. They may look into ways to identify and reduce bias in natural language processing models or create policies for the appropriate application of language services in diverse settings. They can also investigate the potential bias in DLS and make every effort to minimize the bias and provide equal DLS in the future.

Future researchers and practitioners can also examine the way to incorporate the mature DLS into various enterprises [35]. For instance, DLS can be used to review, edit, and refine legal documents that need careful language services assisted with AI technologies. DLS can also be applied to trademarks, customer service, shopping advice, and healthcare which need language services due to diverse requirements. Researchers and practitioners should make every effort to reveal the needs of DLS and break down the barriers to the development and application of DLS in various industries. DLS may become an important motor to drive a large number of enterprises, companies, and universities to develop toward intelligent status. Practitioners and researchers should cooperate at multiple levels and find opportunities to facilitate the development of DLS.

Another important direction in the future may be to study the impact of DLS on the whole of society [36]. With the increasing popularity DLS has received the whole of society may be greatly influenced by the innovative technologies and efficient language services. DLS may alter our living styles and cultural shocks may be minimized due to the convenient communication caused by DLS. DLS may also quicken living paces due to the rapid development of technologies, coupled with innovative and efficient language services. However, DLS may also bring about negative impact on the society. Social injustice may be exacerbated due to different social classes and unequal access to advanced technologies. Future researchers and designers should do their utmost to reduce inequality and enhance social justice.

In general, future research should focus on how to facilitate the development of DLS and innovate the advanced technologies applied to language services, address ethical issues and tackle ethical problems, examine how to successfully integrate DLS into diverse industries, and investigate how to promote the fair environment of the whole society based on the increasingly popular DLS and AI technologies.

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Institutional Review Board Statement

The National Health Commission of China, the Ministry of Education, the Ministry of Science and Technology, and the State Administration of Traditional Chinese Medicine jointly issued the "Notice on Issuing the Ethical Review Guidelines for Life Sciences and Medical Research Involving Human Subjects" on February 27, 2023. Article 32 of the National Health and Science and Education Development [2023] No. 4 stipulates that the use of human information data or biological samples to carry out life science and medical research involving human life in the following situations, which do not cause harm to the human body, do not involve sensitive personal information or commercial interests, can be exempted from ethical review, in order to reduce unnecessary burdens on scientific researchers and promote the development of life science and medical research involving human life.

(1) Research using publicly available data obtained legally, or by observing and not interfering with data generated by public behavior;

(2) Using anonymized information data to conduct research.

This study mainly adopts the form of literature review to collect data, which can be exempted from ethical review according to the regulations.

Informed Consent Statement

This article does not contain any studies with human participants performed by any of the authors.

Data Availability Statement

The data can be available by contacting the corresponding author upon request.

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Conflict of Interest

The authors declare no conflict of interest.

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