Visualising the Knowledge Domain of Linguistic Landscape Research: A Scientometric Review (1994-2021)

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Abstract

Linguistic landscape (LL) is a prism that reflects the linguistic dynamics, language policies, and power relations in given territories. By utilising the scientometric software, CiteSpace 5.8.R3, this paper provides a visualised overview of 654 records and 19746 references (1994-2021) on LL selected from the Web of Science Core Collection (WoSCC). The scientific network analysis, keyword network analysis, and co-citation analysis were undertaken. The leading authors, institutions, and countries in the LL field were identified through scientific network analysis. Analyses of high-frequency keywords and the cluster analysis of keywords identified the hot topics within the LL domain. Document co-citation analysis and co-cited reference clusters were determined to examine influential works and LL research frontiers. The findings indicated that LL research had been expanded from the initial focus on identity and language policy to today's in-depth explorations of language, multilingualism, and English in the globalisation context. In addition, the research object and research approach have made a critical turn to a highly interdisciplinary way.

Keywords: linguistic landscape, CiteSpace, scientometrics, keyword network, co-citation analysis

1. Introduction

The cityscape is covered with a wide variety of linguistic artifacts, for instance, billboards, shop signs, road signs, posters, notices, and other forms of the artifacts. The study of languages in those artifacts is deemed linguistic landscape (LL) research. At a very early stage, LL is briefly defined as "the visibility and salience of languages on public and commercial signs in a given territory or region" (Landry & Bourhis, 1997, p.23). Over decades, the LL field has expanded beyond written texts in public space with the burgeoning development. Currently, the text types include images, drawings, sounds, graffiti, tattoos, and even smells (Shohamy, 2018). The written language displayed in these texts and people's interactions with signage is recognised as the research object (Van Mensel et al., 2016). The expanding definition relatively indicates the multidisciplinary nature of LL studies.

The multidisciplinary nature of LL is manifested in its close relationships with other disciplines, such as semiotics (Scollon & Scollon, 2003), linguistics (Li, 2015), sociolinguistics (Ben-Rafael, 2009), language policy and planning (Han & Wu, 2019), education (Rowland, 2013), ethnic studies (Blackwood & Tufi, 2015), and tourism (Yan, 2019). An increasing number of studies prove that it is necessary to consider LL as an interdisciplinary field instead of restricting it to a particular aspect. Nevertheless, the expanding scope of LL appears to baffle researchers in outlining a panoramic view of this field.

The relatively limited number of LL review articles primarily provides a thematic overview of a particular topic within the LL research field. Shohamy (2012) reviewed the relationship between LL and multilingualism, indicating the impact of globalisation in urban spaces and criticising the documentation method of LL practices. On the other hand, the study predicted the significance of LL in education based on the belief that "a LL can serve as a powerful tool for learning second and foreign languages and for language awareness" (p.547). In another review paper, Shohamy (2018) thematically summarised the development of LL studies and multilingualism from 2006 to 2016 by generating several main themes. The generated themes include LL and representation, LL and multimodality, LL in cities, neighbourhoods and entities, LL and contestation, and LL and education. The primary themes depicted the increasing development of LL studies over a decade and summarised the revolution of theories and methodologies in this field. Nevertheless, two review articles highly centred on LL and multilingualism, neglecting the relationship between LL and other disciplines.

Besides LL and multilingualism, theoretical development and methodological issues are the core topics of other LL review articles. Shang and Zhao (2014) provided a brief review of the theories and methodology of LL, incorporating the research object, data collection process, data analysis method, and theoretical frameworks. Gorter (2018) also reviewed and criticised to-date methods, data collection, and presentation techniques and advocated technological innovations during data collection and analysis.

Compared to the studies discussed above, Van Mensel et al. (2016) offered a relatively comprehensive overview of LL studies, including the historical development, core themes, and theoretical and methodological issues. Nevertheless, the analysed documents were selected based upon the representation of the articles or the research objectives due to the qualitative research methods of the literature (Randolph, 2009). The number of selected documents was relatively small but not exhaustive. The review process typically depends on the authors' prior knowledge and literature review (Guo &Wang, 2017). Thereby, the conclusions of the literature lack generalisability to some extent. Hence, this study attempts to quantitatively visualise the knowledge domain of LL research with the assistance of a science mapping tool-CiteSpace, to depict a more comprehensive and interdisciplinary overview of the LL status quo and offer a future direction for this field.

The scientometric method with CiteSpace, involving computational or quantitative and visual analytic approaches, allows a broader range of publications to be assessed and analysed (Chen et al., 2014) and helps the evaluation process be more objective (Liu et al., 2021). Since 2011, CiteSpace has been extensively applied to scientific fields to map a scientometric review of a knowledge domain. Nonetheless, the scientometric method has been recently increasingly employed on topics related to social science fields, such as humour processing (Guo & Wang, 2017), code-switching (Liu et al., 2021), and early education (Wang & Lv, 2021), providing a visualised review of the given research domains.

The scientometric method has started to be applied to LL research. Several Chinese scholars adopted the scientometric method to review the LL research in the Chinese context (Du and Liu, 2021; Li & Wang, 2020). The studies merely focused on Chinese LL studies and avoided integrating perspectives from other regions worldwide. Unfortunately, the studies were insufficient to outline a panoramic view of LL research globally. In addition, two articles reviewed the LL development from an international perspective. Li et al. (2017) adopted the scientometric method with CiteSpace to summarise the current situation of LL studies from 1997 to 2016. Nevertheless, no visual presentation of the findings was present throughout the paper. Only a brief quantitative description of the results was provided, thus the validity and reliability of this paper are questionable. In addition, the paper did not showcase the emerging trends in this field, which is regarded as the biggest weakness. These previous studies were reviewed to provide implications for future research. The other review article (Zhou et al., 2021) adopted another scientometric software, namely the VOSviewer, to undertake a bibliometric analysis of LL research from 2010 to 2019. On the one hand, the covered period is too short to present the earlier LL research development. On the other hand, although VOSviewer can conduct authorship analysis, co-citation analysis, and cluster analysis, it cannot provide a timeline and a time zone view of visualisation and detect the burst, akin to CiteSpace. The time zone or timeline view contributes to a panoramic view of scientific research and its evolution. Concurrently, burst detection helps discover the research frontiers in a particular field (Song & Chi, 2016).

As a result, this paper adopted the scientometric software, CiteSpace to summarise the relevant literature on LL in a visualised and systematic manner. The study aimed to seek the answer to the following questions: (1) Which authors, institutions, and countries/territories make great contributions to LL research? (2) What are the hot topics in LL research during the past decades? (3) How has LL research developed and what emerging trends can be detected during this period? By exploring these questions, the study helps to clarify the development of LL research.

2. Method

The dataset used in this study was from the Web of Science Core Collection (WoSCC). The WoSCC was selected because it could provide a set of data including titles, authors, institutions, countries, keywords, abstracts, cited references, funding, and other details crucial for the systematic review. Scopus is capable of providing similar metadata. Nonetheless, the dataset from Scopus cannot be directly used unless it is converted to Web of Science (WoS) format due to the incompatibility of CiteSpace. The data from Scopus would experience a possible loss of 1% to 5% due to the data irregularity during the conversion process. By considering these, the dataset was limited to WoSCC.

In order to illustrate the process of data collection, a flowchart diagram (Figure 1) was provided, based upon PRISMA guidelines for systematic reviews. The process mainly included preselection, selection criteria, duplicate removal, and screening. First of all, the "topic" search of "linguistic landscape" was performed. The initial timespan was set from 1991 to 2021 due to the emergence of LL research in the 1990s when Landry and Bourhis (1997) published their seminal work *Linguistic Landscape and Ethnolinguistic Vitality: An Empirical Study*. Nevertheless,

when the initial data collection was conducted, the first relevant literature on LL was found to be published in 1994. Resultantly, the final timespan of the bibliographic data was narrowed down between 1994 and 2021. A total number of 757 records were obtained.
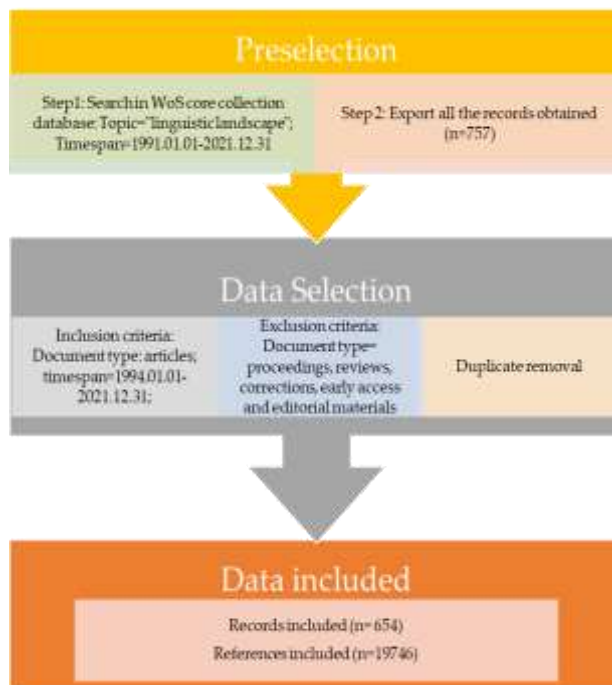

Figure 1. Flowchart of data selection

During the data selection procedure, the study only recognized original articles as research data. Conversely, other research types were excluded, such as proceedings papers, reviews, or editorial materials. The inclusion of articles was due to the originality with a strictly peer-reviewed process, which could better mirror the status quo of this field better (Wang & Lv, 2021). Eventually, 654 articles were gathered as the core dataset, including relevant information, such as author, title, source, abstract, keyword, addresses, cited references and use, funding, and others. After removing the duplicates of these records in CiteSpace, 654 records and 19746 valid references were retained as the bibliographic data for visualising the scientometric review of LL research.

This study used CiteSpace 5.8. R3 (64-bit) to construct the scientific collaboration network, keyword network, co-citation analysis, and cluster analysis. The scientific collaboration network analysis centred on the authorship, institutions, and countries or territories, which quickly helps identify leading authors, institutions, or countries/territories and generate the collaboration map of a particular field (Chen, 2016). The keyword network was employed to identify the hot topics of LL research between 1994 and 2021. The co-citation analysis was used to weigh the impact of the cited authors, studies, and publications (Liu et al., 2021) in the LL research development. Besides, the time zone map and a timeline view of cluster analysis based on co-keywords and co-citations were utilised to explore LL research trends or frontiers.

3. Results

3.1 A General Picture of Authors, Institutions, and Countries/Territories

The general landscape of the LL research domain between 1994 and 2021 was based on multilayered network analysis, including authors, institutions, and countries or territories. The authorship analysis provided the information of core authors and their collaboration network. In contrast, information about institutions and countries or territories offered an analysis of leading institutions and countries or territories.

CiteSpace identified 219 authors from the 636 qualified records. As Wang and Lv (2021) stated, the number of publications is a significant indicator of scientific research activities. Table 1 displays the top nine prolific authors' information in descending order according to the number of articles published. As 17 authors were found to have published three articles and shared the tenth place, Table 1 does not show the authors ranked the tenth place. The top-ranked author by publication counts was Theodorus Du Plessis, with seven articles. Subsequently, Xiaofang Yao,

Jackie Jia Lou, and Durk Gorter published six articles. Nash, Pavlenko, Tufi, and Coluzzi were other prolific authors with more than three publications. These nine authors hailed from different countries and produced 46 articles, accounting for over 7% of the original articles on LL research. Hence, they should be regarded as the core or leading authors within the LL research domain.

Table 1. The top nine authors ranked by number of published articles

Authors	Number of publications	Mean (Year)
Theodorus Du Plessis	7	2009
Xiaofang Yao	6	2020
Jackie Jia Lou	6	2016
Durk Gorter	6	2006
Joshua Nash	5	2012
Aneta Pavlenko	4	2009
Amiena Peck	4	2019
Stefania Tufi	4	2010
Paolo Coluzzi	4	2009

Figure 2 presents the collaboration network of authors in LL research. The collaboration network includes 219 nodes and 135 edges based on a three-year time slice. Nodes in this network represent the author identified from the records, while the edges represent the co-authorship among the authors. The larger node indicates that the author is more influential within the domain than other authors. The presence of more edges proves the greater density of the network. According to Figure 2, the core authors had more connections with others and created their academic circles. In general, the density of co-authorship was not high, with a density of 0.0057. Hence, the density value suggests that collaborations between authors are not active enough and require improvement.

Besides authorships, the analysis of research institutions contributes to understanding the leading institutions and their collaboration network. CiteSpace found 167 nodes and 88 lines with a low-level density of 0.0063, representing the 167 research institutions identified and a low-level collaboration network among institutions. Table 2 displays the top ten core institutions extracted from the dataset, based on the number of publications. Universiti Malaya was the research institution ranked first, with 11 articles. The second rank was shared by the University of the Free State, Nanyang Technological University, and Ghent University, with eight publications. The University of Liverpool and the National University of Singapore published seven articles related to LL research, respectively, and ranked third. Subsequently, the University of Salamanca, University of California, Santa Barbara, University of Jyväskylä and Adam Mickiewicz University ranked next. These core institutions, scattered in Asia, Africa, Europe, and America, indicate the global spread of LL research.

Figure 2. The collaboration network of authors in LL research

Table 2. Core institutions ranked by the number of published articles

Institutions	Number of Publications
Univ Malaya	11
Univ Free State	8
Nanyang Technol Univ	8
Univ Ghent	8
Univ Liverpool	7
Natl Univ Singapore	7
Univ Salamanca	6
Univ Calif Santa Barbara	6
Univ Jyvaskyla	6
Adam Mickiewicz Univ	6

Figure 3 highlights the top ten countries and visualises the collaboration network among countries or territories. CiteSpace identified 224 nodes and 166 edges in terms of countries or territories. The shape of the ring circle reflected each node. Larger node sizes suggest more counted publications of a country or territory, representing more influence within the domain. The United States of America (USA), the top-ranked country, ranked much higher than other countries regarding the number of publications, with 92 published articles, playing a dominating role in publishing LL articles. China was ranked second with 19 published articles, followed by Spain (n = 13). The remaining leading countries in LL research included England, Germany, Malaysia, Russia, Australia, Belgium, and Israel, indicating that LL research is experiencing a burgeoning development in America, Asia, and Europe.

On the other hand, the connection among those countries is easy to find. The deeper the line colour, the stronger the connection. Furthermore, the more the lines, the closer the collaboration. The USA has good cooperation with other top countries, particularly China and Australia. Better cooperation among countries is a frequent practice in LL research. Scientific collaborations would improve the influence of a country within a knowledge domain.

Comparing the top ten institutions and countries, the six top-ranked countries with leading institutions were Malaysia, the USA, England, Spain, and Belgium. Although several countries, including China, Germany, Russia, Australia, and Israel, significantly contributed to publishing articles, these countries have no leading institutions in LL research. Conversely, Singapore, Finland, and Poland have leading institutions within the LL domain. Nevertheless, they are not the leading countries. These findings provide evidence that the results of leading institutions and leading countries have shared similarities but exhibit a slight difference.

According to the distribution of core authors, leading institutions, and countries, conclusively, LL research is not confined to a particular country or territory, but a research field that has attracted increasing attention of scholars worldwide. The more linguistic repertoire a country/territory has, the more LL research it produces. Nevertheless, this finding shows the significance of scientific collaboration in LL research. Although cooperation between countries is frequent, the cooperation between authors and institutions must be improved to promote the global development of LL research.
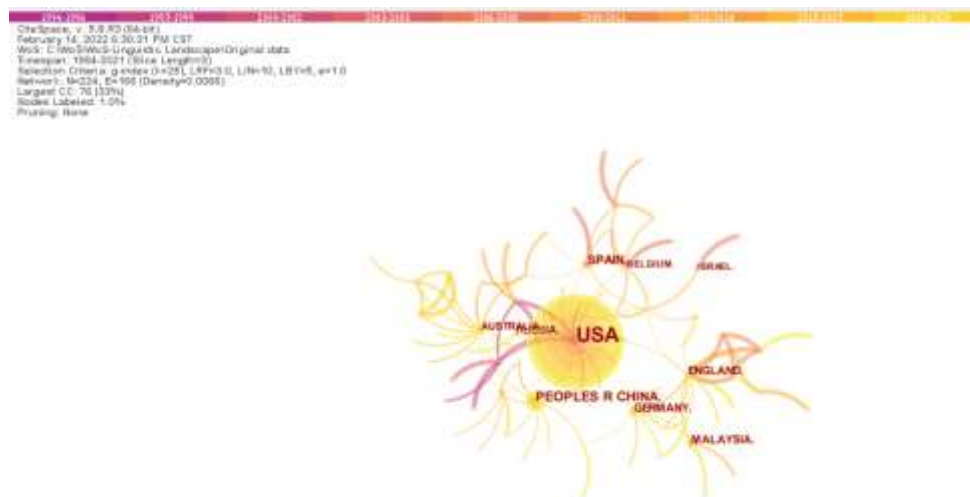

Figure 3. Visualization of the collaboration network of leading countries

3.2 Keyword Network Analysis

One of the biggest benefits of CiteSpace is to detect the high-frequency co-keywords and visualise the hot topics in a given knowledge domain (Chen, 2016). This study adopted the co-keyword network and cluster analysis for a three-year time slice to map the hot topics in LL research from 1994 to 2021.

3.2.1 Keyword Network

CiteSpace extracted 340 keywords from the 636 qualified records. Table 3 summarises the frequency of keywords and lists the information of the top ten keywords with a frequency over thirty, namely "linguistic landscape", "language", "language policy", "English", "space", "identity", "multilingualism", "minority language", "discourse", "ethnolinguistic vitality", "politics". Except for the term "linguistic landscape", keywords such as "language", "language policy", "English", "space", "identity", and "multilingualism", has a close relationship with different disciplines. Keywords, such as "language", "English", "multilingualism", and "discourse", reflect the linguistic aspect of LLs. In contrast, keywords, such as "language policy", "identity", "minority language", and "ethnolinguistic vitality", are more associated with anthropology and sociology. Other keywords, such as "space" and "politics", are related to geosemiotics and the politics of LLs. The distribution of high-frequency keywords coincides with Shohamy and Gorter's (2009) statement that LL is an interdisciplinary research field deeply rooted in linguistics, sociology, anthropology, geosemiotics, and politics.

Table 3. Top ten keywords ranked by the frequency

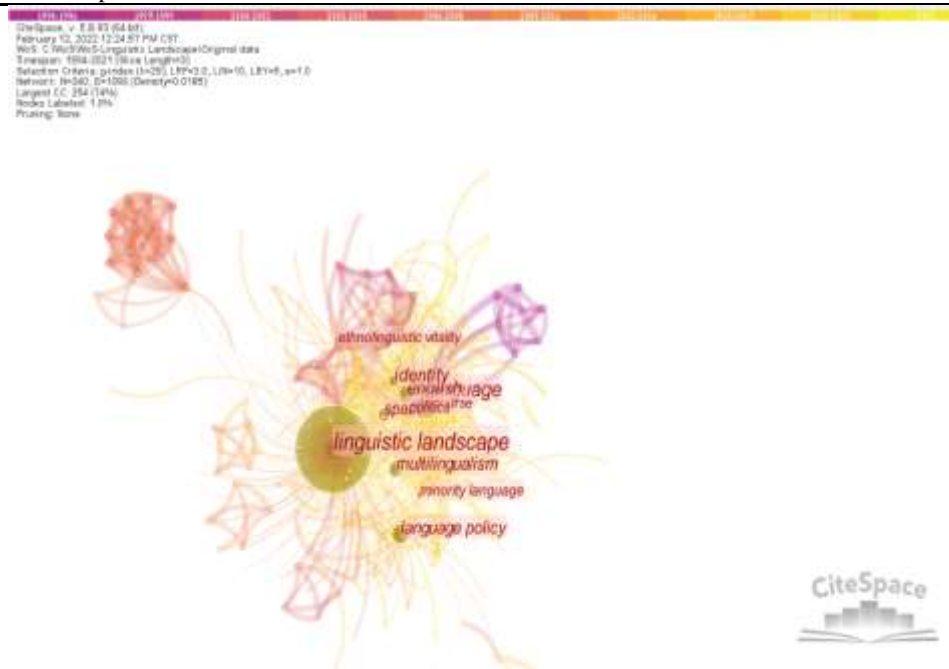| Keywords	Frequency	Mean (Year)
linguistic landscape	361	2004
language	116	1994
language policy	48	2007
English	46	2005
space	31	2012
identity	31	2001
multilingualism	31	2016
minority language	18	2006
discourse	12	2015
ethnolinguistic vitality	11	2001
politics	10	2001

Figure 4. Network of top 10 high-frequency keywords

Figure 4 presents a visualised network of the top ten high-frequency keywords. The larger the node size, the higher the frequency. As Figure 4 shows, a total of 340 nodes and 1066 edges were identified by CiteSpace. Nodes represent the keywords extracted from the records, and edges refer to the links between keywords. The compact but disordered visualisation among keywords suggests that the top ten high-frequency keywords have a close link with each other,

indicating the close relationship between LL research and other disciplines.

3.2.2 Cluster Analysis of Keywords

Subsequently, the study conducted a cluster analysis based on the similarity of co-keywords to explore the hot topics of LL studies. In order to summarise, each cluster was labeled with indexing keywords from the qualified records based on the algorithm log-likelihood tests (LLR). The six largest clusters labeled by LLR are shown in Figure 5. The silhouette value (S = 0.8913), used to measure network homogeneity, was greater than 0.7, suggesting a high quality of the resulting cluster configuration (Li & Chen, 2016). Figure 5 illustrates the relationship between clusters with a time zone view. The time period was divided by a three-year time slice. The time zone map visualised the historical development of LL research and indicated a shift among hot topics.

First, the "linguistic landscape" cluster is the most active cluster with the biggest node and strongest links, indicating its strong vitality since 2000. The result coincides with Van Mensel et al.'s finding (2016), which predicts the first wave of LL studies after the seminal work of Landry and Bourhis (1997). Secondly, clusters such as "identity" and "language policy" show bigger node sizes than other nodes within the timespan from 2000 to 2010. The finding indicates that LL research focused on broader social topics, such as identity (Stroud & Mpendukana, 2009; Taylor-Leech, 2012) and language policy (Spolsky, 2004) in an earlier stage. With the burgeoning development of LL research since 2010, the LL research has shifted from a sociological perspective to a linguistic or sociolinguistic perspective. In other words, LL studies have developed a close association with language, English, and multilingualism since 2010.
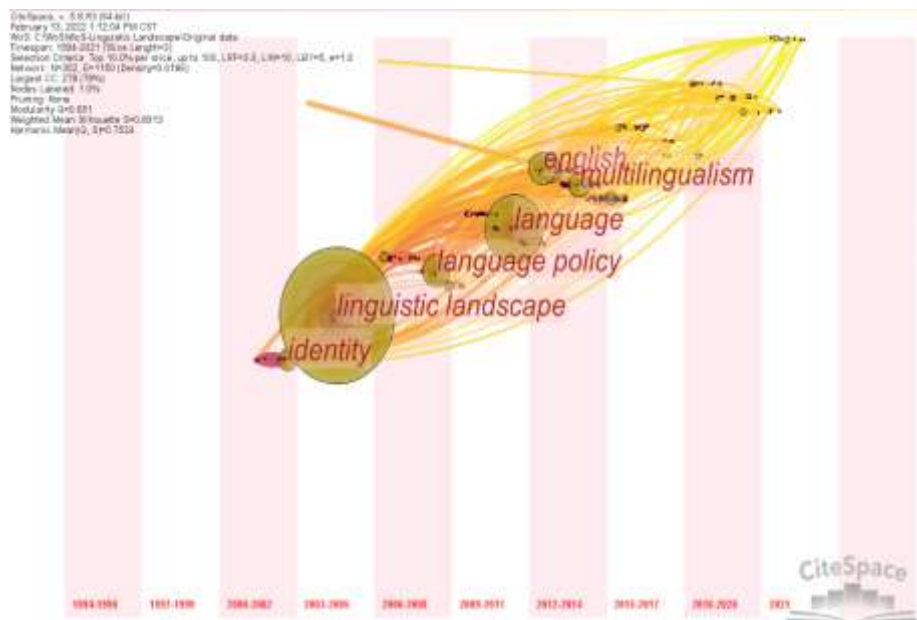

Figure 5. A time zone map of keyword clusters in LL research.

In the initial stage, LL research has centred on identity. Many studies have explored the indexical function of social and national identity by examining the language choice displayed in the public space. The language used in public space is more associated with the collective identity of a group (Ben-Rafael et al., 2006). Subsequently, the LL is regarded as a lens to reflect the local language policy in a given territory (Cenoz & Gorter, 2006; Du Plessis, 2009). High emphasis has been placed on the role of language policies in modeling LLs. After a critical turn to linguistics and sociolinguistics, LL becomes a new approach to multilingualism and the global spread of English by providing newly written data in the public space (Gorter, 2006).

An array of case studies has been conducted globally to explore the societal multilingual phenomenon in given cities, such as Tokyo in Japan (Backhaus, 2007), Kyiv in Ukraine (Pavlenko, 2009), Kuala Lumpur in Malaysia (Manan et al., 2015), and Guangzhou in China (Han and Wu, 2019). Language choice and language hierarchy are the main research object during this period. The literature proves that multilingualism is a norm in the public space due to the driving force of globalisation, even in countries long stereotyped as monolingual. The public space evolves into a power arena of conflict and contestation (Rubdy & Said, 2015) into a battlefield of different languages (Lamarre, 2014). In addition, a considerable body of multilingual LL studies has witnessed the practise of language mixing,

translanguaging, language hybridity, and creativity (Van Mensel et al., 2016).

As a global language, English is the most heated topic among LL-related and multilingualism-related studies. Bolton (2012) proposed combining LL and English and thereby encouraged a wide variety of interdisciplinary research to study English in the public space, particularly in countries located in the Outer and Expanding Circles, where English functions as an essential second or foreign language (Kachru, 1992). Previous studies adopted various approaches to explore English mixing, emerging English variety, and linguistic creativity or hybridity between local languages and English. For example, Lawrence (2012) utilised a mixed-methods approach to examine the use of English in Korean LLs. The findings indicated evidence of the existence of Konglish, a glocal variety of English influenced by the Korean language. Similarly, a study in a Pakistani city shared similar results concerning the glocalisation of English in LLs (Manan et al., 2017). Similar findings can be identified in other Asian cities. Li (2015) summarised the features of Chinese-English language mixing and linguistic creativity in a qualitative study on Chinese LLs. A quantitative study in a northern Jordanian city revealed the English-Arabic mixing practice and the hybrid or creative linguistic forms in commercial signage (Alomoush, 2018). Hence, most LL studies related to the use of English in the public space agree with the global spread of English and the emerging English variety worldwide.

Besides, the functions of English in LLs have been discussed. Many previous studies regarded English as a symbolic marker that indexes high-quality, modernity, and internationalised orientation (Han & Wu, 2020; Strandberg, 2020). English in non-English commercial texts serves a symbolic, decorative, and promotional function rather than an informative function (Kasanga, 2012). English is an economic and commercial commodity (Manan et al., 2017). These studies have opened a new age for English studies from a LL approach, including language contact, language variety, and the symbolic and commodified value of languages.

Although a focus on topics exists within each time slice, these hot topics in LL research are not independent but interconnected. The lines between the clusters illustrate the connection. The density of the lines reflects the closeness of the relationship between each topic. Furthermore, the links of these clusters have long time spans, indicating that these hot topics have lasted for a long time and maintains active to date. Conclusively, those themes remain hot topics in LL research.

3.3 Document Co-citation Analysis

The other biggest benefit of CiteSpace is conducting the co-citation analysis to weigh the impact of authors, studies, and publications and identifying hot topics and frontiers of a knowledge domain (Li & Chen, 2016). Besides co-authorship and co-keyword analysis, this study also conducted document co-citation and cluster analysis. Co-authorship and co-keyword analysis focus on the collected records. Nonetheless, document co-citation analysis is based on the references of the collected records. The analysis, combining the records and their references, assists in outlining a highly comprehensive picture of the hot topics and the frontiers of the LL knowledge domain from 1994 to 2021.

3.3.1 Co-citation Analysis

The co-citation analysis in this study was conducted to weigh the influence of studies in LL research development based on the co-cited relationship among references. Figure 6 visualised the document co-citation network of LL research from 1994 to 2021 and highlighted the top ten cited references.

The document co-citation network included 527 nodes and 1804 edges for a three-year time slice. The nodes represent cited references extracted from the collected records, while edges represent the co-citation relationships among the cited references. The size of the node corresponds to the quantity of the citations. In other words, large node sizes suggest that the reference is influential within the knowledge domain. Each node is illustrated by the shape of tree rings across the time slices. Table 4 supplemented the detailed information of the document co-citation network and listed the top ten most-cited works in descending order.

Figure 6. Document co-citation network

The most cited work is an edited volume entitled *Linguistic Landscape in the City*, in which 18 articles investigated the dynamics of LL across cities, including several themes: multilingualism, power relations, perceptions of people, and multiculturalism (Shohamy et al., 2010). This edited volume is an influential work at the early stage of LL research by conducting systematic and multifaceted empirical investigations of LL in cities to theorise LL research from a diverse perspective. The second most cited work discussed the multilingual phenomenon in Tokyo by researching the LL along traffic lines (Backhaus, 2007). The monograph written by Backhaus becomes the first influential work providing a detailed and rigorous methodology of LL research, later employed by an array of relevant studies. The third most cited work was Blommaert's monography. Blommaert (2013) examined the LLs located in the author's neighbourhood from a sociolinguistic perspective. The biggest advantage of Blommaert's work lies in providing a diachronic perspective to read multilingual signs. As discussed above, the top three cited works play an influential role in theorising LL research from the sociological, sociolinguistic, and linguistic perspectives and outlining the methodological frameworks for subsequent relevant studies.

The rest of the most cited works emphasis different perspectives of LL research. Jaworski and Thurlow's (2010) edited volume compiled a series of articles to explore the relationship between language, image, and space highly associated with semiotic, discursive, and social aspects of LLs. Ben-Rafael et al. (2006) compared the LLs in Israel and East Jerusalem localities and elaborated on the role of LL in power relations and identity construction. Spolsky (2009) theorised LL from a sociolinguistic approach and proposed three principles of language choice. The other four works focused on different topics related to LL research, such as LL and minority language (Cenoz & Gorter, 2006), LL and mixed-method approach (Papen, 2012), LL and globalisation (Ben-Rafael & Ben-Rafael, 2015), LL and immigrant language (Leeman & Modan, 2009). These most cited works have expanded the LL research scope and attempted to provide a theoretical and methodological framework for future studies. The strong links between the nodes (Refer to Figure 5) indicate the cited works' co-citations. In addition, these works have a long time span, suggesting LL research experienced a burgeoning development in research objects, theories, and methodologies.

Table 4. Top ten critical works in LL research

Cited Frequency	Title	Author(s)	Year
63	Linguistic landscape in the city	Shohamy, Ben-Rafael & Barni	2010
37	Linguistic landscapes: A comparative study of urban multilingualism in Tokyo	Backhaus	2007
28	Ethnography, superdiversity and linguistic landscapes	Blommaert	2013
26	Semiotic landscapes: Language, image, space	Jaworski & Thurlow	2010
26	Linguistic landscape as symbolic construction of the public space: The case of Israel	Ben-Rafael et al.	2006
20	Prolegomena to a sociolinguistic theory of public signage	Spolsky	2009
20	Linguistic landscape and minority languages	Cenoz & Gorter	2006
20	Commercial discourses, gentrification and citizens' protest: The linguistic landscape of Prenzlauer Berg, Berlin	Papen	2012
19	Linguistic landscapes in an era of multiple globalizations	Ben-Rafael & Ben-Rafael	2015
18	Commodified language in Chinatown: A contextualized approach to linguistic landscape	Leeman & Modan	2009

Figure 7. A timeline view of clusters based on the co-citation network

3.3.2 Identification of Clusters Based on Co-citation Network

The document co-citation network was divided into several clusters based on the similarity of co-cited references tightly connected within the same clusters to explore research patterns of the knowledge domain. CiteSpace identified ten clusters based on a document co-citation network and displayed the largest six clusters. The rest of the clusters were omitted due to their small sizes. Figure 7 provides a timeline view of the largest six clusters. In order to summarise each cluster, the clusters were labelled with noun phrases from the abstract of articles based on log-likelihood tests (LLR). The details of these six clusters are listed in Table 5 in ranking order. A weighted mean silhouette value (S = 0.8896), greater than 0.7, suggests a high quality of the cluster configuration.

As shown in Table 5, Cluster #0 is the largest cluster with 91 nodes. The average publication year is 2015. According to the abstract content of the articles, Cluster #0 was labeled as "case study", as shown in Figure 7. The term "case study" is often viewed as a research method associated with anthropology, sociology, and language education to explore society, culture, and the role individuals play in society (Hood, 2009). Nevertheless, "case study" refers to an empirical investigation of a phenomenon within its real-life context (Yin, 2009). The bounded system of a case in LL research comprises a particular research site. In the "case study" cluster, researchers' interests were primarily

concerned with the multilingual LL in different cities. A city is akin to a particular case for researchers. Hence, LL studies frequently choose a particular city (Huebner, 2006; Lawrence, 2012; Manan et al., 2015) or compare two different cities (Blackwood & Tufi, 2015; Kallen & N íDhonnacha, 2010) to examine language representations in the public space. These cities, either located in Europe, America, the Middle East, Asia, or Africa, share multilingual characteristics in the global context but differ in language representations. Each city is similar to a kaleidoscope of linguistic artifacts and a repository of power relations, offering a myriad of case studies for LL research.

The second-largest cluster (Cluster #1) comprises 80 nodes and the average publication year is 2008. The cluster is related to the language choice in LL research. Language choice is a significant aspect and the most basic analysis perspective of studying LL, particularly in an early research stage, focusing on the salience and visibility of languages in a given territory. Emphasis has been placed on documenting language representations and language hierarchies in given areas. The LL research on language choice is concerned with topics, such as identity (Ben-Rafael, 2009), globalisation (Huebner, 2006), and language policy (Du Plessis, 2012). As language choice is the primary object, the methodology prefers a quantitative approach. In the early stage, exploring language choice becomes the most basic analytical paradigm for LL studies.

The third-largest cluster (Cluster #2) is referred to as "minority language" with 64 nodes. The average publication year is 2011. The LL approach is regarded as particularly appropriate to study the dynamics of minority language situations in society (Marten et al., 2012). A plethora of studies focused on the visibility of minority languages in written form in the public space. The studies investigated central issues concerning minority languages, such as ideology (Szab ó & Troyer, 2017), language policy (Cenoz & Gorter, 2006), ethnolinguistic vitality (Shohamy & Ghazaleh-Mahajneh, 2012), language maintenance, and language revival (Holmes, 2013) in the globalisation context. Although undertaken in different cities or territories, relevant studies revealed the strong role of language policy in affecting minority languages (Cenoz & Gorter, 2006). In addition, the LL approach would deepen the "comprehension of language policies, power relations, and ideologies in minority language settings" (Van Mensel et al., 2012, p.319).

In addition, Cluster #3 is also worth mentioning. The cluster indicates an emphasis on multilingual adverts in the public space. The average publication year is 2016. Besides, Cluster #3 explains multilingual advertising as one of the biggest data sources of recent LL research. Landry and Bourhis (1997) initially elaborated on the significance of advertising in LL research by exemplifying the LL items, including public road signs, advertising billboards, street names, place names, commercial shop signs, and public signs. Subsequently, Ben-Rafael (2009) pointed out the predominant role of commercial activities in creating multilingual signage. Alomoush (2018) also suggested the positive relationship between business activities and the visibility of multilingualism. These statements increasingly raise the attention to multilingual adverts in the public space. Resultantly, a myriad of LL research has collected multilingual adverts as the new LL data to study multilingualism and the global spread of English in the public space (Bolton, 2012; Lawrence, 2012; Lee, 2019; Li, 2015).

Table 5. Top-ranked Clusters in LL Research

Cluster	Size	Silhouette	Mean (Year)	Label (LLR)
0	91	0.914	2015	Case study
1	80	0.854	2008	Language choice
2	64	0.764	2011	Minority language
3	53	0.891	2016	Multilingual advertising
4	44	0.952	2005	South Africa
5	23	0.996	2017	Quantitative approach

Cluster #4 is related to South Africa, a particular LL research region. The average publication year is 2005. The time span of Cluster #4 indicates that South Africa provides an array of earlier LL studies and plays an influential role within the knowledge domain in the early stage. The result corresponds with the findings of leading authors and research institutions discussed in prior sections. Among the 26 core authors in the LL field, Theodorus Du Plessis, a professor at the University of the Free State, South Africa, who is the head of the Department of South African Sign Language and Deaf Studies, and an associate editor of Language Matters Journal, ranked the first place with the maximum of seven LL articles. The University of the Free State ranked second place among the leading institutions, with eight publications. The mean years of these publications were 2009, parallel with the findings of the co-citation cluster analysis. These results provide evidence of the significant effect of scholars from South Africa on LL research.

Cluster #5 focuses on the quantitative approach of LL studies. The LL research development approach coincides with the expansions of the LL definition. The most quoted LL definition comes from Landry and Bourhis (1997). They defined LL as "the visibility and salience of languages on public and commercial signs in a given territory or region" (p.23). Visibility refers to the language distribution in an area, whereas salience is related to language hierarchies on signs. The visibility and salience of languages tend to be investigated quantitatively by counting signs documenting the percentage and distribution of languages. The booming stage of LL research since 2006 has witnessed various quantitative studies (Han &Wu, 2020; Manan et al., 2015). Nevertheless, the quantitative approach is criticised for its over-simplicity and decontextuality when the definition turns to an inclusive, humanistic, and contextual direction (Gorter, 2018; Tufi & Blackwood, 2010). To date, researchers (Barni & Bagna, 2015; Blackwood, 2015) suggest a synergetic approach, combining the quantitative and qualitative approaches, to understand complex and multifaceted linguistic dynamics in the public space better.

The presentations of the above clusters assist in analysing the hot topics of LL research. The research objects have expanded from the initial focus on language choice to an in-depth exploration between LL and minority languages, multilingualism, and commercial activities. The research methods involving the case study and quantitative approach have made significant progress with the knowledge domain development. In addition, South Africa, with the leading author and leading institutions within the field, plays an influential role in the early process of LL studies. Nonetheless, the analysis of leading countries or territories discussed above indicates a shift from South Africa to the USA, China, and Spain concerning the leading countries in the LL research field to date. Currently, LL research is a hotly discussed study field that attracts attention from scholars globally.

4. Discussion

From the network analysis of authors, institutions, and countries or territories, academic collaboration is observed to help increase the influence of authors, institutions, and countries in the LL research field. The core authors, institutions, and countries tend to build a close relationship with others, consequently increasing their influence within a research domain to a certain extent. Besides, the global distribution of core authors, institutions, and research countries or territories is witnessing a blooming LL research field globally. Nevertheless, the relatively low co-authorship density reflects the absence of core academic circles in the field. The social network among authors must be improved since it is valuable for resource sharing and the hidden dangers of closures (Wang & Lv, 2021). An excellent scientific collaboration network could facilitate the sustainable development of a research domain.

As Figure 5 shows, the LL research field has shifted from the initial focus on the sociological perspective to today's multi-dimensional perspectives, including sociological, linguistic, and sociolinguistic with the evolvement of theories and methods. The time zone view of keyword clusters highlighted the key topics in the respective time span, namely identity, language policy, language, multilingualism, and English. Generally, these terms derive from different disciplines, such as sociology and linguistics, indicating the interdisciplinary nature of LL research. On the other hand, the interdisciplinary LL studies help expand the scope of the field to a broader perspective. At an earlier stage, the LL is specifically akin to a lens reflecting the local language policies and an index of identity (Van Mensel et al., 2012) by investigating the language choice and language hierarchy presented in public signage.

Subsequently, LL provides a myriad of newly written texts to language contact, language varieties, and language shift in the globalisation context. Nowadays, the LL has been deemed a new approach to multilingualism and the globalisation of English (Gorter, 2006). Although different time spans present different research focal points, each hot topic is interconnected instead of being independent of each other. Furthermore, these topics maintain their research vitality for an extended period and are still heatedly discussed in up-to-date LL studies.

In the development process of LL research, an array of critical works has been identified through the document co-citation network analysis. Figure 6 and Table 4 display detailed information on the top ten critical works and their co-citation network. The critical works, namely the edited volumes, the monograph, or original papers, have emphasised different perspectives of LL research, ranging from theoretical constructions and methodological explorations to diverse topics, such as minority languages, people's interactions with LL, globalisation, and the functions of languages. The results have shown the overlapped part with the co-keyword analysis and further supported the discussions above, indicating the interdisciplinary nature of LL research.

According to the co-citation network, a timeline view of cluster analysis (Refer to Figure 7) has displayed the hot topics in the development process and helped identify the research field frontiers. The clusters presented the evolvement of LL research in research regions, objects, and methodologies. Firstly, South Africa plays an influential role in an earlier stage in terms of research regions as the average year of publication was 2005. The existence of core authors and leading institutions indicates the significance of South Africa in the LL field. Nonetheless, the

research centre has shifted to the USA, China, Spain, and other Asian or European countries based upon the analysis of leading countries, signaling the global spread of LL research.

Secondly, the research object has shifted from language choice in a given territory to minority language and multilingual advertising in the public space. The minority language in the LL is associated with identity, ideology, language policies, and power relations. In contrast, multilingual advertising in LLs is focused on multilingualism, globalisation, and English. Last but not least, the methodology has experienced a critical turn. The quantitative approach was once the most widely adopted methodology by documenting the frequency and distribution of languages to record language visibility and salience of the public space.

Nevertheless, the expanded LL research scope, including language representations and people's interactions with these signs (Shohamy, 2012; Van Mensel et al., 2016), has triggered methodological changes, from quantitative to qualitative (Szabó & Troyer, 2017), incorporating ethnography, interviews, and surveys. The focal points of methodologies identified by co-citation analysis suggest the co-existence of qualitative and quantitative approaches in LL research. Blackwood (2015) argued that a mixed-methods approach, combining the quantitative and qualitative analysis, is "an ideal modus operandi" (p.40) to portray complex and multifaceted linguistic dynamics in the public space.

5. Conclusion

The study examined and visualised the evolutionary trajectory of LL research from 1994 to 2021 according to scientific collaboration network analysis, co-keyword analysis, and co-citation analysis, with the aid of a scientometric software, CiteSpace. The collaboration network analysis identified the core authors, leading institutions, and leading countries. The USA, China, Spain, Malaysia, and South Africa are the primary contributing forces in LL research. The co-keyword analysis extracted hot topics from the literature within this knowledge domain. Topics such as identity, language policy, language, multilingualism, and English have been heatedly discussed. The LL research field had a prominent interdisciplinary feature through the document co-citation analysis, ranging from sociology to semiotics, linguistics, and sociolinguistics. The timeline view of clusters based on the document co-citation network vividly outlined the LL research evolution in research centres, objects, and methodologies.

Undoubtedly, LL research is a blooming and fascinating field. Conducting a scientometric approach to track the dynamics and frontiers in this domain using large-scale data and computational methods (Guo & Wang 2017) is valuable. Nevertheless, similar to other bibliometric methods, the scientometric approach is subjected to limitations. On the one hand, only the first author can be extracted, and the role of co-authors could be neglected in identifying authors of articles and references. On the other hand, the scientometric approach is primarily based on the collection of keyword frequency, and citation counts identify to what extent the frequency and counts could reflect the significance of a specific reference remains unknown (Liu et al. 2021).

Although several limitations exist, the scientometric approach is a novel and objective approach to understanding the research forces, hot topics, and future trends of a specific knowledge domain. This paper may not provide a complete panoramic view of the LL knowledge domain. Nonetheless, it visualises the evolvement of LL research over time and highlights the hotspots and critical works, which could triangulate previous LL reviews.

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