Research Paper

Revisiting Neighborhood Sustainability Assessment Tools: A Systematic Review of Evolution, Application, and Prospects

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Abstract

Neighborhood Sustainability Assessment Tools (NSATs) have played a important role in designing of sustainable neighborhood and the implementation of global sustainability goals over the past two decades. To clarify the research trends and future research directions of NSATs, this paper conducts a systematic review of 200 articles from the Web of Science and Scopus databases, using both quantitative and qualitative analysis methods. The Knowledge Map of keywords clusters from bibliometric analysis indicates that early studies mainly focused on the typical NSATs, especially LEED ND, while recent studies have increasingly paid attention to NSATs in developing countries. The qualitative analysis reveals four main research topics: (1) the development path of NSATs; (2) the comparative analysis and optimization of NSATs; (3) the correlation between NSATs and sustainability; (4) the application of NSATs. And it identifies several persistent challenges, including insufficient digital integration as well as inadequate local adaptability. In order to optimize NSATs, this study proposes two research directions for the future: (a) Integrating digital technologies to enhance alignment with the Sustainable Development Goals (SDGs); (b) Optimizing indicators and frameworks based on different regions to expand their applicability in various countries. The findings provide a solid foundation for advancing NSATs and guiding the development of more adaptive, evidence-based sustainability assessment tools.

Keywords

Neighborhood Sustainability Assessment Tools, Systematic Review, the Sustainable Development Goals, Future Research Directions

1. Introduction

Sustainable development has become the mainstream under the background of carbon neutrality and climate change. As the fundamental unit of cities, neighbourhoods play a important role in achieving urban sustainability. No single city can contribute to overall sustainability if its own component parts are found not to be sustainable(Choguill, 2008). Therefore, Neighborhood Sustainability Assessment Tools (NSATs) have gained increasing attention in the past two decades(Shari, Dawodu and Cheshmehzangi, 2021).

Nowadays, more than 40 NSATs are available in the global, with representative examples including LEED ND in the U.S., BREEAM Communities in the U.K., CASBEE UD in Japan, and DGNB UD in Germany (Shari, Dawodu and Cheshmehzangi, 2021).Scholars have conducted reviews to clarify the origin, classification, evolution, structure, and application of NSATs(Sharifi and Murayama, 2013; Ameen, Mourshed and Li, 2015; Wangel et al., 2016; Tam et al., 2018; Kaur and Garg, 2019; Pedro et al., 2019; Grazieschi, Asdrubali and Guattari, 2020; Sharifi, Dawodu and Cheshmehzangi, 2021; Dawodu et al., 2022; Khatibi, Khaidzir and Mahdzar, 2023). However, it is found that the previous studies still present several limitations. In terms of content, previous studies have focused on the tools themselves, with limited attention to scholarly perspectives. Furthermore, the comparative analysis adopted by the previous studies is less pay attention to the NSATs from developing countries due to the consideration of maturity and application(Sharifi and Murayama, 2013), which means the existing research lacks a global perspective. In terms of method, there are few literature reviews that use quantitative analysis. Nevertheless, it is necessary to increase the use of quantitative analysis in NSATs research. Sharifi and Murayama (2013)found that the accuracy of research results of NSATs is limited by the use of qualitative research methods after measuring 117 papers. Grazieschi, Asdrubali and Guattari (2020)also used literature metrology and cluster analysis to track the concept changes of in the concept of sustainability over different periods, which is conducive to the development of NSATs.

2. Methodology

This study aims to review the trend and clarify future research directions of NSATs over the past two decades by using quantitative and qualitative analysis method. Therefore, the structure is as follows: Section 2 introduces the research methodology and data sources; Section 3 presents the Knowledge Map by using VOS viewer; Section 4 provides a systematic review of key research themes and related findings; Section 5 and 6 concludes with the findings, future directions and limitations of this study.

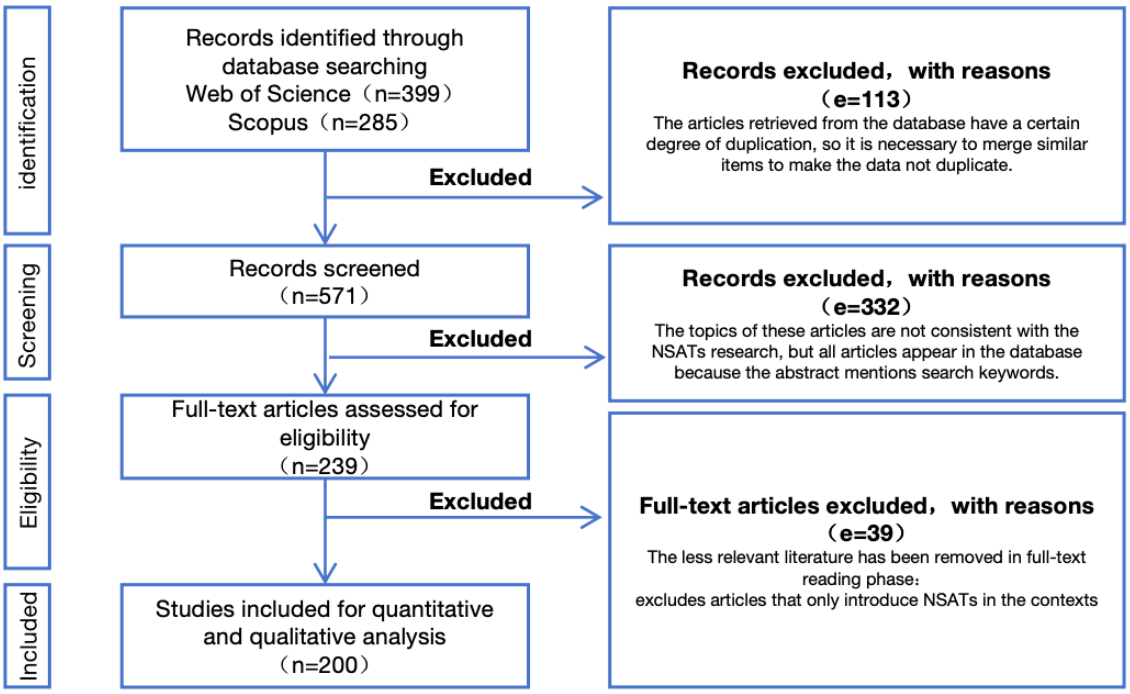

Figure.1 Workflow diagram of literatures screen phase by using PRISMA 2020 protocol. Source: Authors,2025.

This study adopts an integrated approach that combines quantitative bibliometric analysis and qualitative content analysis. Quantitative bibliometric analysis was conducted using VOSviewer to draw the Knowledge Map of keywords clusters and identify research trends of NSATs research from 2000 to 2025. Subsequently, qualitative content analysis was used to systematically reveal research themes and trends.

According to Komeily and Srinivasan (2015), NSATs has other variant names in previous studies, including urban community assessment tools, district sustainability assessment tools, neighborhood sustainability rating tools, sustainable community rating tools and so on. Considering this situation, this study also review literature related to variant names above.

The literature search followed the PRISMA guidelines and was conducted through the Web of Science and Scopus databases (Figure.1), using keywords related to Neighborhood Sustainability Assessment Tools and other variant names. The literature search covered publications from 2000 to 2025 (until September 1, 2025) and was limited to English-language sources. The initial search had 684 records, which were reduced to 571 after removing duplicates. Following title and abstract screening, 239 articles remained. After full-text review and team consensus, 200 articles were selected as the final data for this study.

3.Quantitative Analysis Results

3.1. Analysis of Keywords Clusters

In order to show the research direction more clearly, this study uses VOSviewer to carry out bibliometric analysis and generate Knowledge Map of keywords clusters (Figure.2), in which items with the same color belong to the same cluster. The four-color clusters in the Knowledge Map respectively show the four mainstream directions of NSATs research, covering the entire process from tool development to application.

Cluster1 includes keywords such as sustainability, neighborhood, urban planning, urban area, project assessment, case study, economic and social effects, policy making, quality of life, etc. This indicates that the research focuses on the application of NSATs in urban environments, especially the economic and social sustainability of practical projects.

Cluster2 includes keywords such as urban sustainability, sustainability assessment, indicators, sustainable development and sustainable neighborhood, GIS, spatial analysis, etc. This indicates that the research focuses on the relationship between assessment indicators and sustainability dimensions, while also attempting to use new spatial analysis tools in the assessment process.

Cluster3 includes keywords such as LEED ND, BREEAM Communities, CASBEE UD, comparative analysis, sustainability assessment tools and development projects, etc. This indicates that the research focuses on NSATs of the U.S., the U.K., and Japan through comparative analysis. Furthermore, it also explores the practical application of three NSATs above.

Cluster4 includes keywords such as assessment tools, climate change, environmental design, green buildings and environmental assessment, energy, greenhouse gases, carbon, eco-design, etc. This indicates that the research focuses on environmental sustainability, and paying attention to the practical utility for green buildings, energy efficiency and carbon emission.

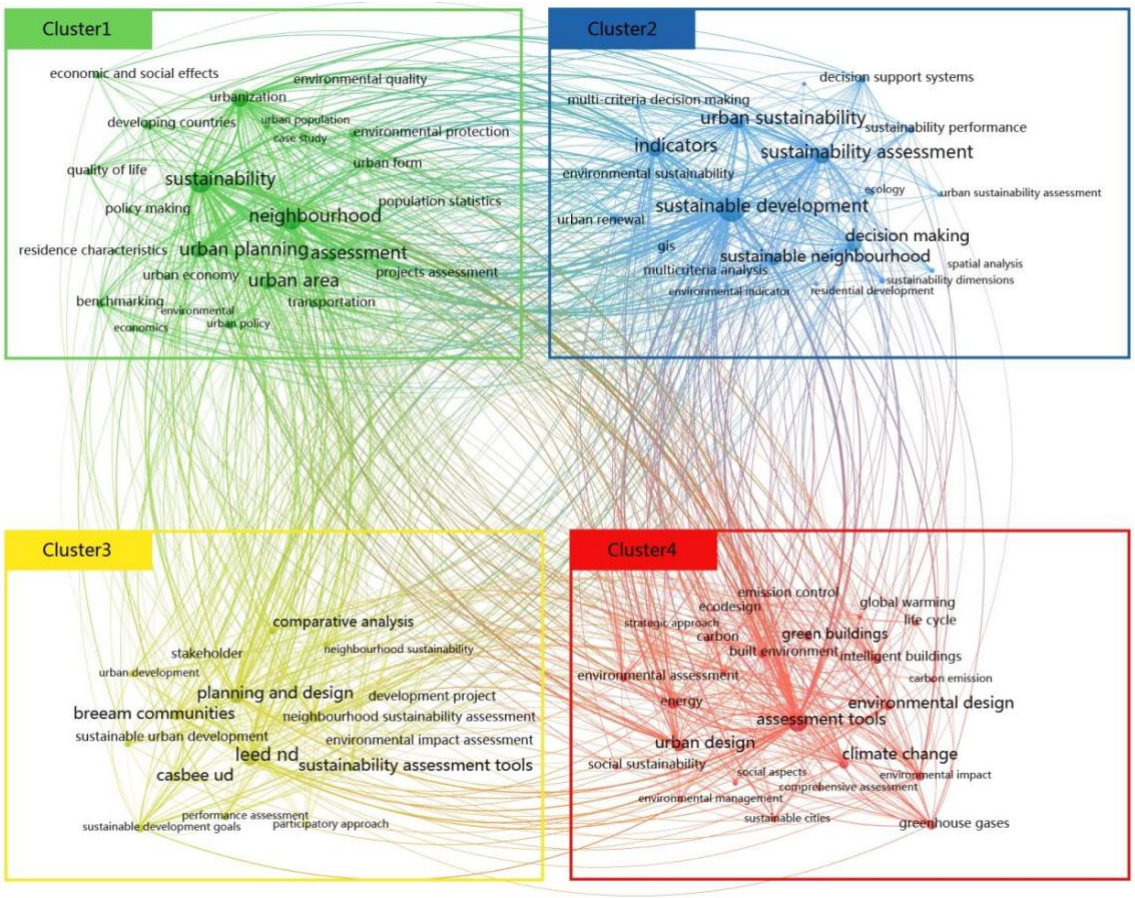

Figure.2 Knowledge Map of keywords clusters in NSATs research from 2000 to 2025. Source: Authors,2025.

3.2. Analysis of historical keywords trend in publications

The Knowledge Map of average publication year for keywords was generated using the overlay view in VOS viewer (Figure.3). The analysis shows that early studies mainly focused on LEED ND, energy and green buildings. As time went by, the research focus shifted to evaluation indicators, sustainability, BREEAM Communities and comparative analysis. In recent years, the the United Nations Sustainable Development Goals (UN SDGs), case studies, developing countries, the social dimension, the social sustainability, social economic effect and other keywords are highlighted.

The changes in research focus during different stage reflect three trends in the NSATs research. In terms of research subjects, the scope has expanded from developed countries to covering developing countries. In terms of research methods, there has been a shift from the comparative analysis of indicators to case study method in recent. In terms of research content, early studies mainly focused on environmental sustainability, while recent studies have demonstrated a deeper alignment with the UN SDGs and have paid more attention to the economic and social dimensions of sustainability.

Based on the results of bibliometric analysis, this study summarizes four topics of NSATs research: 1. Introductory study: focusing on the introduction and development of NSATs; 2. Comparative study: exploring the optimization direction by comparing different NSATs; 3. Relevance study: investigating the correlation between NSATs and sustainability; 4. Application study: analyzing the effectiveness and limitations of NSATs in practical application.

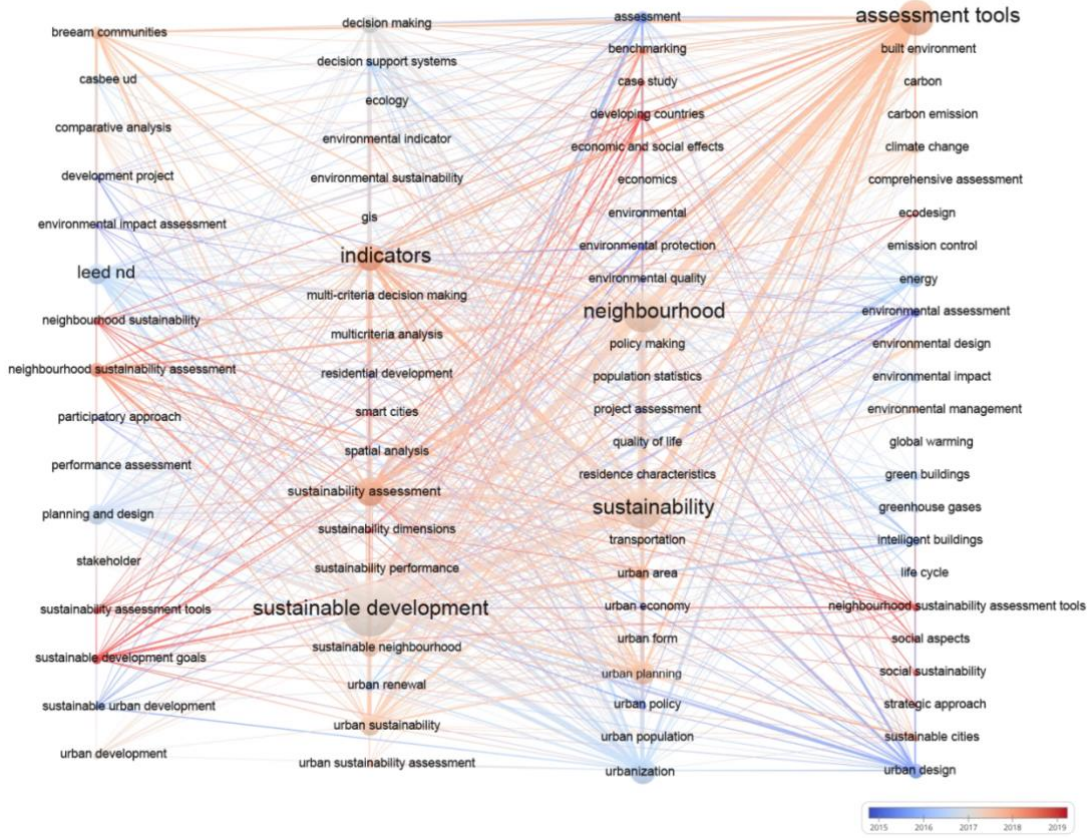

Figure 3. Knowledge Map of Average publication year for keywords from 2000 to 2025. Source: Authors,2025.

4. Qualitative Analysis Results

4.1 Introductory study: Introduction and development of the NSATs

NSATs has evolved from the SBATs, and its application scope has gradually expanded to a broader urban scale. Early research mainly focused on NSATs developed by leading institutions such as the U.S. Green Building Council, the Building Research Establishment of the United Kingdom, and the Germany Sustainable Building Council. For example, Murakami et al. (2007)described CASBEE-UD in detail, which became earliest systematic explorations in NSATs research.

With the global promotion of these typical NSATs, related research has gradually focused on developing new assessment tools for specific community backgrounds(Asaad et al., 2024b). This type of research focuses on how to develop an effective assessment framework, with a particular emphasis on sustainability models, including the selection of indicators and methods(Li et al., 2024).The choice of a sustainability model determines the assessment dimensions embedded in NSATs. Commonly adopted frameworks include the triple bottom line model(Reith and Orova, 2015), the quadruple bottom line model (Dawodu, Cheshmehzangi and Akinwolemiwa, 2018), the five-capital model (Subramanian et al., 2021), and the pentagonal model(Kumar, Bhaumik and Banerji, 2021). These models provide conceptual guidance for indicator selection and weighting. The indicator selection of NSATs adopts a combination of top-down and bottom-up methods. The top-down method is based on expert evaluation and screens out core indicators from typical NSATs(Dawodu, Cheshmehzangi and Williams, 2019). The bottom-up method screens

indicators through public participation, reflecting the social inclusiveness and regional adaptability(Mattarozzi and Antonini, 2011).

In the development of framework and indicators weights of NSATs, existing literature has mentioned the Delphi expert consultation method(Lee and Lee, 2020). To enhance the effectiveness of NSATs, previous studies combined Delphi expert consultation with objective mathematical modelling methods. Guided by sustainability models and expert consultation, the framework is established through a screening process firstly (Renthlei and George, 2025). The indicators weights are then derived using mathematical models, resulting in a quantifiable NSAT(Sharif et al., 2022).

Meanwhile, researchers began to explore the optimization of existing NSATs by the scoring expression. The first way is to use multidimensional radar chart to express scores, and to improve the effectiveness of NSATs by presenting the advantages and disadvantages in different sustainable dimensions (Vandevyvere, 2011; Vandevyvere, 2013). The second way is to integrate digital technology tools into the existing NSATs, such as collecting the scores based on GIS and presenting the sustainability performance of different communities in maps (Pedro, Silva and Pinheiro, 2018; Yunda, 2019; Orozco-Messana, Iborra-Lucas and Calabuig-Moreno, 2021; Abastante and Gaballo, 2022)

4.2 Comparative study: exploring the optimization direction by comparing different NSATs

Comparative study on NSATs aims to clarify their advantages and limitations by systematically analysing existing indicators and frameworks. Early studies primarily compared the structure of rating systems. Gil and Duarte (2010) categorized the structure of NSATs into a pyramid model composed of dimensions, issues, criteria, indicators, and benchmarks. Later, Wangel et al. (2016)refined this model by linking the four levels of NSATs (labels, categories, issues, and indicators) with corresponding weights and scores. With the increasing abundance of research results, recent studies have focused more on the comprehensive application of comparative analysis in review. For example, Grazieschi, Asdrubali and Guattari (2020) pointed out that energy transition and climate change are the two core issues that shape the research pattern of NSATs through bibliometric analysis. Shari, Dawodu and Cheshmehzangi (2021); Sharifi, Dawodu and Cheshmehzangi (2021) summarized nine key limitations and two success factors of NSATs, and pointed out the optimization for future.

Indicators are the main issue of NSATs. Comparative studies of indicators can provide important insights for optimisation of NSATs. Brodie et al. (2013); Marique (2015); Gouda and Masoumi (2017)evaluated the accessibility and connectivity of communities by comparing transportation indicators of NSATs. Zhang et al. (2019)proposed strategies to enhance urban energy performance by examining the renewable energy indicators in NSATs. Yoon and Park (2015)identified the optimization direction by analysing material indicators in NSATs of various countries. In recently, comparative studies has expanded to thematic levels. Diaz-Sarachaga and Jato-Espino (2019)compared the resilience indicators of NSATs with urban resilience assessment tools. Aguiar Borges, Hammami and Wangel (2020)examined the heritage protection indicators from LEED ND and BREEAM Communities. Dawodu, Cheshmehzangi and Sharifi (2021); Dawodu et al. (2021)systematically reviewed community participation and institutional indicators in NSAT. These studies all reveal the shortcomings of existing NSATs in resilience, heritage protection and institutional inclusivity.

Comparative study was also conducted in the analysis of case studies. The global adoption of NSATs could be identified by comparing the certified projects, including their number, certification levels, and geographical distribution. Sharifi and Murayama (2014)used the cross-cases comparative method to compare certification projects from LEED ND, BREEAM Communities and CASBEE UD, which points out that

none of the above NSATs fully reflect comprehensive sustainability, highlighting the need for a more integrated assessment framework.

4.3 Relevance study: investigating the correlation between NSATs and sustainability

NSATs established an indicator framework that reflects multiple sustainability dimensions, which guides communities towards sustainable development. The indicators in NSATs could be summarized into environmental, social, economic, cultural and institutional dimensions, by analyzing the correction between the indicators and the sustainability dimensions. However, existing studies shows that the current NSATs generally emphasize environmental dimension indicators, and pay less attention on social, economic, institutional and cultural dimensions(Ameen, Mourshed and Li, 2015; Kaur and Garg, 2019; Elkamhawy, ElEashy and Elfiky, 2024). This imbalance reflects the environmental bias in NSATs, which make it difficult to reflect the status of well-being, governance and cultural identity of communities. Therefore, it has become an essential optimized direction to integrate social inclusiveness, institutional effectiveness and economic feasibility into NSATs in recent studies(Dawodu, Cheshmehzangi and Sharifi, 2021; Kumar and Banerji, 2022; Xie et al., 2022).

The relevance between NSATs and the UN SDGs also reflects its effectiveness for sustainable communities. LEED for Cities and Communities, BREEAM Communities and DGNB UD have successively benchmarked against with the UN SDGs framework to enhance the international promotion of NSATs(BRE, 2017; DGNB, 2020; USGBC, 2020). Based on this, Saiu, Blečić and Meloni (2022) proposed a cross-analysis method to evaluate the contribution of NSATs to the UN SDGs. This method identifies the indicators in NSATs that promote the UN SDGs and converts to contribution values to different SDGs based on the weights of indicators. It shows that the current NSATs significantly support SDG 11 and SDG 13, while have relatively weak connections in related goals such as social well-being, fairness and institutional governance. How to transform the UN SDGs into indicators to guide community planning and integrate them into NSATs remains to be further explored(Saiu, Blečić and Meloni, 2022).

4.4 Application Study: analyzing the effectiveness and limitations of NSATs in application

The application of NSATs in different contexts not only demonstrates its potential but also exposes its limitations. Since NSATs were initially developed based on specific social environment and climate conditions, when they are directly applied to different regions, it often indicates adaptive barriers, such as differences in climate, resource, governance and cultural, which may lead to the disconnection between NSATs and local environment. In practical applications, common challenges include the misalignment of sustainability, the limited responsiveness to some indicators, and the difficulty for typical NSATs to address the development needs of developing countries(DOUSSARD, 2017; Gouda and Masoumi, 2018; Dang et al., 2020).Therefore, scholars advocate the development of localized NSATs(Li et al., 2024; Renthlei and George, 2025). For example, Sharifi and Murayama (2015)proposed to reconstruct the indicator database through public participatory processes, enabling local stakeholders to screen indicators and integrate social utility value into the framework of NSATs.

In addition to context adaptation, the effectiveness of NSATs for community planning is increasingly being recognized(Asaad et al., 2024a). NSATs helps embed sustainability into design process and guides planners to make decisions. Jensen, Bjerre and Mansfeldt (2016)pointed out that compared with traditional planning methods that rely on visual or conceptual approaches, planning based on NSATs can give rise to more refined sustainable solutions. Although the application of NSATs cannot cover all process of designing, it could provide valuable sustainability reference benchmarks at the conceptual stage. What's

more, NSATs could also be used to assess how urban form guidelines drive the sustainable development of communities. For example, after using LEED ND to evaluate several communities in Hong Kong, Zhang (2022)found that urban form design criteria had limitations in guiding community site selection and green community construction. Comparing to traditional land use planning, NSATs can also be combined with urban form design criteria, and indicators can be linked to urban form design parameters through urban typology, such as road network density, connectivity, diversity, spatial distribution, and so on(Garde, 2018).

Although the existing NSATs have established relevant indicators for public participation, the effectiveness has not yet been fully exerted. Due to the top-down expert evaluation logic in the development of some NSATs, the dimension of public participation has not received substantial attention. To address the limitations of NSATs in promoting public participation and municipal governance, recent studies have proposed several paths for improvement. On the one hand, the assessment process can be enhanced by integrating field investigation (Horgan and Dimitrijević, 2019) This approach enables the identification of challenges in community sustainable development by collecting public opinion, which in turn clarifies optimization directions. On the other hand, elements such as governance mechanisms, decision-making processes, and institutional designs can be embedded into the original NSATs framework, which could ensure a balanced relationship among the four sustainability pillars by assigning weight of public participation indicators(Dawodu, Cheshmehzangi and Sharifi, 2021).

5. Discussion：Future research direction of NSATs

Future research should promote the deep integration of theory and application, so as to further improve the applicability of NSATs on a global scale.

In terms of theory and methodology, the new generation of NSATs should particularly focus on aligning with the quantitative indicators from the UN SDGs (Saiu et al., 2024). Meanwhile, NSATs could integrate technical tools and investigate possibilities of intelligent tools such as digital twins and large language models in dynamic assessment (Lami and Abastante, 2025). These efforts would contribute to the optimization of framework that holistically balance environmental sustainability, social inclusivity, economic feasibility, and governance effectiveness.

In terms of practice and application, future research of NSATs should bridge the gap between theory and implementation. On the one hand, institutions need to verify the effectiveness of different NSATs in real scenarios, especially in developing countries, through cross-national case comparisons. On the other hand, institutions should promote the localization adaptation of NSATs on the basis of fully considering regional characteristics(Li et al., 2024; Renthlei and George, 2025). Moreover, integrating application feedback into the iteration of NSATs is also very important by establishing a dynamic optimization mechanism.

6. Conclusion

This study systematically reviews 200 literatures on neighborhood sustainability assessment tools selected from the Web of Science and Scopus databases from 2000 to 2025, by using quantitative and qualitative analysis methods. Bibliometric analysis indicates that early studies mainly focused on the comparative analysis between LEED ND and other typical NSATs, while recent studies have increasingly paid attention to NSATs in developing countries and begun to focus on issues related to economic, social and sustainable development goals.Qualitative analysis reveals four topics: (1) the introduction and development of NSATs; (2) the comparative analysis and optimization of NSATs; (3) the correlation between NSATs and

sustainability; (4) the application of NSATs. Overall, a relatively systematic study of NSATs has been established, but most research still focuses on typical NSATs, especially LEED ND. In order to optimize the NSATs, this study proposes two research directions for the future: (a) Integrating digital technologies to enhance alignment with the Sustainable Development Goals (SDGs); (b) Optimizing indicators and frameworks based on different regions to expand their applicability in various countries.

With the ongoing progress of global urban sustainability, topics such as digital twin, health, carbon neutral and resilient city will continue to be integrated into the NSATs. Consequently, the research trends identified in this study need to evolve accordingly. Therefore, it is necessary to continuously pay attention to the development trends of NSATs, combine the latest research results, and thereby promote research in this field.

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