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INTEGRATED APPROACHES TO SUSTAINABLE URBAN DEVELOPMENT: THE SYNERGY BETWEEN LANDSCAPE ARCHITECTURE AND CIVIL ENGINEERING

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Abstract. This research study addresses the developing synergy between landscape architecture and civil engineering in the context of sustainable urban development. The study intends to analyze how these multidisciplinary professions might collectively handle urban difficulties while assuring long-term environmental, social, and economic sustainability. Using the PRISMA technique, the study thoroughly reviewed secondary data from the Scopus database, identifying 23 relevant publications published between 2015 and 2024. The study outlines major integration techniques, obstacles, and emerging trends that impact the cooperation between various disciplines. The results emphasize major impediments to successful multidisciplinary collaboration, including policy fragmentation, inadequate cross-disciplinary education, and technology adaption issues. Additionally, the research underlines the significance of merging theoretical frameworks and practical case studies to increase the knowledge of integrated urban development techniques. By offering a comprehensive examination of the literature, this study adds to a greater knowledge of interdisciplinary urban planning solutions and gives significant insights for policymakers, academics, and practitioners working toward resilient and adaptable urban environments.

Keywords: sustainability, urban development, landscape architecture, civil engineering.

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1. Introduction

In an era marked by increasing urbanization, the pursuit of sustainable urban development stands as one of the most important global priorities. The decisions we now make on urban planning, design, and architecture will have a significant environmental, societal, and economic impact as more than 55% of the world's population now lives in cities (Zeng et al., 2022; Wang et al., 2022). Urbanization poses many complex problems that require multifaceted solutions that cross traditional disciplinary boundaries and draw on the collective wisdom of many disciplines (Bixler et al., 2022; Butt & Dimitrijević, 2022). Civil engineering and landscape architecture have become key elements in these areas, poised to change the course of urban development (Ananiadou-Tzimopoulou & Bourlidou, 2017; Rusan et al., 2022). The intersection of land use planning and civil engineering represents a dynamic intersection of knowledge and creativity. Landscape architects have long been recognized for integrating the built environment with the natural world and emphasizing principles of aesthetics, function, and sustainability (Maltseva et al., 2018; Calvagna, 2020; Yang et al., 2014). In parallel on the contrary, civil engineers form the backbone of urban infrastructure, responsible for designing and building critical systems that shape the functioning of our cities. These include transport networks, water supply, sanitation, etc. (Aktan et al., 2021; Hooimeijer et al., 2022). It is within these two disciplines that deep synergies occur, offering innovative and integrated solutions to urban challenges of difficulty.

This paper embarks on a journey to explore and inform the evolving relationship between landscape architecture and civil engineering in urban sustainability. Through the lens of different industries, this research seeks to examine how their collaboration contributes to the creation of urban spaces that can meet immediate needs while also safeguarding the well-being of future generations. In doing so, the research examines the many determinants of this interaction, from designing and implementing green infrastructure (Shin et al., 2020) to developing sustainable transportation systems (Sayyadi & Awasthi, 2016), renewing the cities to the waterfront (Jun, 2023; Samant

& Brears, 2017), and cultivating resilient urban ecosystems (Landis, 2016).

The convergence of landscape architecture and civil engineering plays a significant role in resolving the expanding difficulties of sustainable urban development, where functional infrastructure must coexist with environmental resilience and aesthetic value. While civil engineering ensures the durability and efficiency of urban systems such as transportation networks, water management, and public utilities, landscape architecture contributes to ecological balance, climate adaptation, and public well-being through green infrastructure and nature-based solutions (Rusan et al., 2022; Zhou, 2024). Despite the rising acknowledgment of multidisciplinary cooperation, research suggests that fragmented policies, restricted communication, and a lack of cross-disciplinary education limit the efficient integration of various sectors (Lievens & Moons, 2022). This research intends to bridge this gap by studying the processes via which landscape architecture and civil engineering interact in urban sustainability, identifying challenges to their integration, and providing methods for more cohesive cooperation. A thorough literature review underscores the significance of combining structural resilience with ecological design, encouraging urban environments that are not only functional but also adaptable to climate change, socially inclusive, and economically viable (Liao et al., 2023b; Alipour & Dia, 2023).

As the global community grapples with pressing issues such as climate change, resource scarcity and the need for inclusive urban development, the need to take on integrated approaches in urban planning is clear (Chu et al., 2016; Wamsler et al., 2019). This paper seeks to be a beacon for scholars, practitioners, policymakers, and stakeholders, shedding light on the transformative potential of landscape architects and civil engineers mobilized to shape the future of urbanization not only efficient and functional but also aesthetically pleasing, and socially equivalent. It is also biologically stable. The pages that follow reveal a complex story of entrepreneurship and innovation, where the worlds of landscape architecture and civil engineering intersect to shape the sustainable cities of tomorrow.

As urbanization increases globally, cities confront rising issues linked to environmental degradation, infrastructural resilience, and sustainable resource management. Addressing these difficulties demands an integrated strategy that harnesses the knowledge of different disciplines. This research explicitly addresses the interaction of landscape architecture and civil engineering, stressing their significance in building sustainable urban landscapes. The major purpose of study is to comprehensively examine how different disciplines interact to increase urban sustainability, identify challenges to successful integration, and provide solutions to improve cooperation. To do this, the research applies the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) approach for Systematic Literature Review (SLR), providing a controlled and transparent selection of relevant academic publications. This methodological approach allows for a full synthesis of previous research, stressing both theoretical aspects and practical applications. By bridging the gap between civil engineering's focus on infrastructure development and landscape architecture's emphasis on ecological and social well-being, this study contributes to advancing interdisciplinary urban planning practices and informs policy recommendations for future urban development.

2. Theoretical background

Urbanization is a transforming force that alters economic, social, and environmental landscapes. As global urban populations continue to rise, cities confront enormous difficulties relating to infrastructure sustainability, environmental resilience, and public well-being. Addressing these difficulties involves interdisciplinary teamwork that includes civil engineering and landscape architecture, two areas that play complementary roles in constructing urban landscapes. Civil engineering focuses on developing strong and efficient infrastructure systems, such as transportation networks, water management facilities, and smart city technology. Meanwhile, landscape architecture helps by building environmentally sustainable, visually attractive, and socially inclusive settings that increase urban livability. The convergence of these two disciplines is vital for attaining sustainable urban development, as it guarantees that constructed environments are both structurally robust and environmentally harmonious (Alipour & Dia, 2023). However, despite their interwoven functions, the integration of civil engineering and landscape architecture remains fragmented owing to disparities in professional practices, governmental restrictions, and a lack of multidisciplinary education. This section investigates the theoretical underpinnings that underlie the confluence of these areas and presents a conceptual framework for increasing their synergy in urban planning and development.

One of the most significant theoretical methods to understanding the combination of civil engineering and landscape architecture is General Systems Theory (GST), proposed by Bertalanffy (1968). GST offers a comprehensive paradigm for understanding urban settings as interdependent systems, where diverse aspects interact dynamically. In this setting, infrastructural networks, natural systems, and human activities constitute a complex web of interactions, necessitating coordinated management across disciplines. For instance, stormwater management systems in cities should not only be planned for efficiency but also designed with green infrastructure components, such as bioswales, retention ponds, and permeable pavements (Ashinze et al., 2024). These projects exhibit systems thinking, where civil engineers and landscape architects work to enhance flood prevention, water conservation, and ecosystem restoration in metropolitan contexts. Similarly, urban transportation planning benefits from this integrated viewpoint, since constructed road networks must be supported by pedestrian-friendly green corridors and transit-oriented projects to promote sustainable mobility (Bibri et al., 2020). By employing systems theory, urban planners may create cities that work as cohesive, adaptable, and resource-efficient entities, rather than fragmented infrastructures that fail to fulfill environmental and social concerns.

In addition to systems theory, the Sustainable Development Theory acts as a basic pillar for combining civil engineering and landscape architecture in urban planning. First expressed in the Brundtland Report (1987), this approach stresses the significance of addressing present urban requirements while protecting resources for future generations. In the context of urbanization, sustainability is accomplished by balancing economic development, environmental conservation, and social well-being. Civil engineering helps to sustainability by using energy-efficient materials, low-carbon building processes, and smart infrastructure solutions (Berglund et al., 2020). Landscape architecture supports this by boosting urban biodiversity, providing climate-resilient green spaces, and building socially inclusive public places (Liao et al., 2023a). For example, green roofs, urban trees, and nature-based solutions contribute to air quality improvement, carbon sequestration, and microclimate adjustment, strengthening the principles of sustainable development. Moreover, combining land use planning with environmental protection reduces urban expansion and ecosystem degradation, ensuring that cities flourish in an environmentally responsible way (Alipour & Dia, 2023). The United Nations Sustainable Development Goals (SDGs) further strengthen this paradigm, notably Goal 11, which strives to promote inclusive, safe, and resilient urban environments (United Nations, 2015). By incorporating sustainable development concepts into urban policies and design practices, communities may shift toward a more balanced and regenerative growth model that harmonizes infrastructure expansion with environmental conservation.

The Urban Resilience Framework offers another significant theoretical viewpoint, especially in the context of climate change and environmental vulnerabilities. Urban resilience refers to a city's ability to predict, absorb, and recover from external shocks, including natural catastrophes, resource shortages, and socio-economic disturbances (Meerow & Newell, 2019). Civil engineering plays a significant part in urban resilience by designing climate-adaptive infrastructure, such as flood-resistant buildings, earthquake-proof bridges, and smart energy networks. However, infrastructure resilience alone is inadequate; landscape architecture helps by incorporating natural buffers, such as wetlands, mangroves, and permeable landscapes, which increase flood mitigation and biodiversity protection (Palazzo & Wang, 2022). Additionally, heat-adaptive urban design, including tree canopy extension and reflecting surface materials, mitigates urban heat island impacts and increases thermal comfort for city inhabitants (Campagna et al., 2020). Urban resilience also extends to social and economic elements, where the establishment of inclusive public spaces, green mobility networks, and community-driven urban initiatives enhances social cohesion and economic stability. By adopting a resilience-based urban planning strategy, communities may proactively address future issues while promoting sustainable and livable urban ecosystems.

Beyond theoretical models, policy frameworks play a vital role in determining the integration of landscape architecture and civil engineering in urban sustainability. The Leipzig Charter on Sustainable European Cities (2007) is an important policy statement that calls for integrated, compact, and ecologically sensitive urban development (European Commission, 2007). This strategy underlines the need for integrated land use planning, green infrastructure integration, and smart urban governance, ensuring that urbanization corresponds with sustainability goals. Similarly, the Baltic Sea Region Sustainability Strategy stresses coherent urban development models that prioritize climate adaption, green mobility, and ecosystem preservation (Zandersen et al., 2019). Policymakers play a critical role in bridging the disciplinary boundary between civil engineering and landscape architecture by establishing multi-sectoral policies that enable collaborative decision-making, stakeholder involvement, and regulatory coherence. Additionally, international urban planning frameworks, such as the New Urban Agenda (UN-Habitat, 2016), call for combining nature-based solutions with infrastructure development, supporting the need for sustainable, resilient, and people-centered cities. Aligning urban development plans with these global and regional policy frameworks ensures that urban sustainability transitions are both evidence-based and practicable.

Technological improvements further increase the interaction between civil engineering and landscape architecture. The development of Building Information Modeling (BIM) and Digital Twin technologies has changed urban planning and infrastructure management by providing real-time monitoring, predictive analytics, and integrated design simulations (Bittencourt et al., 2024). BIM helps engineers and landscape architects to examine energy efficiency, stormwater dynamics, and land use patterns, supporting data-driven decision-making in urban sustainability design (Ferko et al., 2022). Digital Twin technologies, which produce virtual duplicates of urban settings, enable real-time insights on environmental conditions, infrastructure performance, and climate effect assessments (Deng et al., 2021). By incorporating these smart city technologies, urban planners may optimize resource allocation, minimize environmental impacts, and boost urban resilience, assuring that future cities are more intelligent, adaptable, and sustainable.

The combination of civil engineering and landscape architecture is anchored by a rigorous theoretical and policy framework that promotes systems thinking, sustainability, resilience, and technology innovation. By integrating General Systems Theory, Sustainable Development Theory, and the Urban Resilience Framework, this research underscores the vital necessity for multidisciplinary cooperation in urban planning. Additionally, integrating urban policy with new technology and global environmental objectives produces more flexible, livable, and future-ready cities. Moving forward, strengthening cross-disciplinary education, policy alignment, and technology-driven solutions will be essential in bridging the gap between infrastructure development and ecological integration, ensuring that urban environments remain resilient, inclusive, and environmentally sustainable.

3. Methodology

This section discusses the methodology used in the study to examine the growing connection between landscape architecture and civil engineering in urban sustainability. The study will look at how diverse industries collaborate to create urban places that can address urgent demands while also protecting the well-being of future generations. This section has two primary topics that explain how to apply the PRISMA methodology to improve data collection, selection, and scholarly discussion of the results.

3.1. Literature search and data collection strategy

This study primarily relies on secondary data acquired from a SLR of research on the same subject. The SLR was carried out in perfect accordance with the PRISMA protocol. The primary goal of SLR is to identify the most relevant research using objective techniques such as bibliometric analysis to give an alternative or supplement to existing methodology (Martinho, 2022). The PRISMA procedure in SLR aids in the assessment and improvement of the quality of systematic reviews and meta-analyses in any subject (Nagendrababu et al., 2018). The PRISMA approach for SLR, according to Page et al. (2021), involves the generation of research questions, keyword selection, database selection, literature search and retrieval, screening, inclusion and exclusion, data extraction, and analysis. Figure 1 illustrates the steps used to collect data for the analysis in this study.

After defining the study's objective, pertinent keywords related to the integration of civil engineering and landscape architecture for sustainable urban development were discovered. The literature search was performed in Elsevier Scopus, since it is a reputable database containing research and periodicals pertinent to civil engineering and urban development. The Scopus database offers comprehensive coverage of journal articles indexed in other databases. The Scopus database was chosen because it provides comprehensive coverage of engineering and sustainability-related literature, including high-impact journals on urban planning and environmental science. However, Web of Science (WoS) also offers valuable academic sources, and its inclusion could enhance the research. The full search string used in the Scopus database is given as TITLE-ABS-KEY ((sustainable AND development OR urban AND development OR landscape AND architecture) AND (civil AND engineering OR construction)) AND PUBYEAR > 2014 AND PUBYEAR < 2025 AND (LIMIT-TO (DOCTYPE , "cp") OR LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")). The first

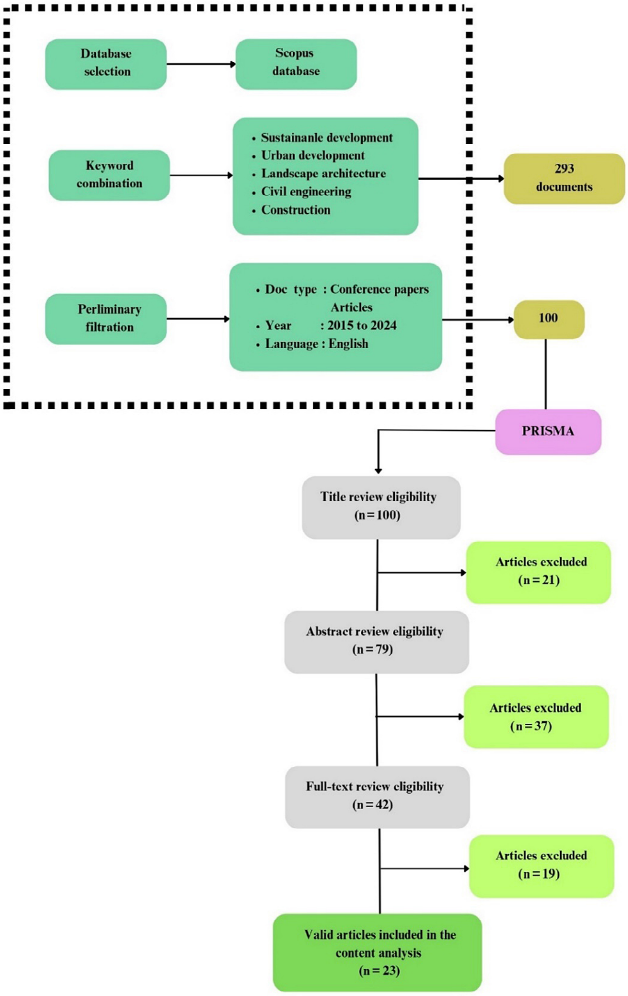

Figure 1. Document filtration process through Scopus database and PRISMA method

search yielded 293 documents. The search was further limited down by choosing just conference proceedings and journal articles. This method reduced the overall document count to 229. Only publications produced between 2015 and 2024 were chosen due to the recent emergence of contemporary landscape architecture and the integration of new civil engineering concepts. This resulted in 104 documents. Since Scopus also indexed publications published other than English, only English-utilized documents were selected. The last collection of papers yielded a total of 100. These 100 downloaded articles were carefully screened under 3 steps; title sift, abstract-sift, and full-text sift. The title sift conducted by looking at the relevancy of the article addressing the synergy between civil engineering and urban development. After the inclusion of the relevant articles the abstract sift was conducted by reviewing the purpose and aims of each research article. Several irrelevant articles were excluded. Finally, the full-text sift was conducted by screening the content of the specific paper. The title, abstract, and full-text evaluation narrowed the sample into 23 articles which were critically reviewed to extract relevant data based on the objectives of the study.

3.2. Data analysis

To delineate the sampled articles, the study extracted various data including type of study, year of study, the purview of the study, reported methods for sustainable urban development, integration of various landscape architectural methods, synergy of civil engineering and landscaping, challenges and barriers for proper integration of these two domains, potential strategies on how to incorporate civil engineering methods and landscaping architectural designs. A data summary sheet was created to record the extracted data and their sources. Consequently, the study provided detailed discussions on the extracted methodologies and strategies. VOS Viewer 1.6.20 was used for data visualization and it is a software that analyzes bibliometric data, such as abstracts, to measure research innovation and identify key themes in each study (Alifariki et al., 2022).

4. Bibliometric analysis

4.1. Primary information of documents

The publishing trends from 2015 to 2024 demonstrate in Figure 2 a variable but generally favorable rise in research focusing on the combination of landscape architecture and civil engineering for sustainable urban development. Initial interest in 2015, with 8 articles, saw a modest decline in 2016, followed by steady growth in 2017 and 2018, each with 11 publications. This growth may reflect the increased understanding of the need for multidisciplinary methods in urban sustainability, especially as global initiatives like the United Nations SDG gained have. The peak in 2021, with 15 publications, implies that the topic acquired substantial impetus, presumably motivated by post-pandemic recovery efforts that stressed sustainable urban design. Despite declines in 2020 and 2022, the research interest remained significant, suggesting that combining landscape architecture with civil engineering continues to be a key field of study. The trend demonstrates the changing and resilient character of this study topic as cities strive towards long-term sustainability objectives.

The citation overview given in Figure 3 throughout the years demonstrates a rising awareness and effect of research focusing on the integration of landscape architecture and civil engineering in sustainable urban development.

In the early phases, citation counts were quite low, with only 3 citations in 2016 and 16 in 2017. This steady expansion implies that although early research was essential, it required time for the academic and professional communities to fully engage with and reference these multidisciplinary works. By 2018 and 2019, the citations climbed to 21 and 46, respectively, showing the field's expanding significance. This time undoubtedly benefitted from heightened global awareness about urban sustainability, as cities worldwide started incorporating sustainable techniques into their planning and building initiatives. The study in this sector became widely recognized as it linked with the worldwide drive for more sustainable urban settings. From 2020 onwards, there was a large jump in citations, with 98 in 2020, 131 in 2021, and 171 in 2022. This fast growth may be linked to the heightened worldwide attention on climate change, urban resilience, and sustainable development objectives, where the convergence of civil engineering and landscape architecture plays a key role. The year 2023 witnessed a further jump to 184 citations, and in 2024, the citations had already skyrocketed to 215, showing the extensive use and importance of research in this field. The increased citations show that the study is now recognized as crucial to defining sustainable urban practices, impacting both academic and industry practices at a worldwide level. The increasing quantity of citations indicates how highly esteemed the study is among the academic community and how crucial it is in influencing ongoing scholarly discussions. The citation summary was further narrowed by identifying the top ten referenced articles. The 10 most cited papers are shown in Table 1 after this element was investigated based on the number of citations these articles received.

Table 1 gives a quantitative summary of the most referenced papers relating to sustainable urban development,

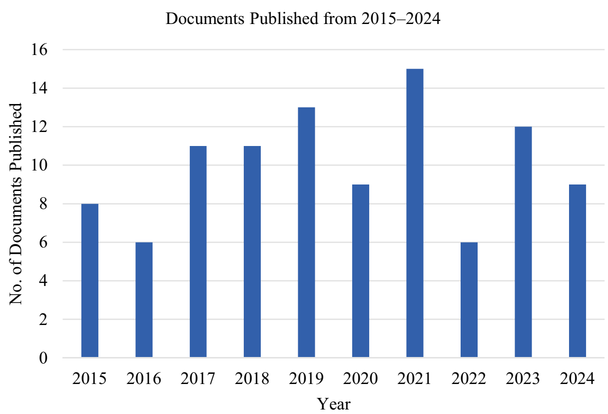

Figure 2. Documents published and indexed in the Scopus database from 2015 to 2024

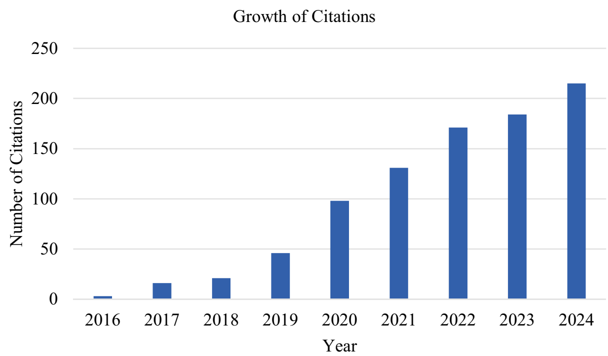

Figure 3. Growth of citations received for the documents published and indexed in Scopus from 2015 to 2024

Table 1. Top 10 cited articles identified through Scopus database analysis

No.	Article title	Author(s)	Year of publication	Citations received
01	Structural stay-in-place formwork for robotic in situ fabrication of non-standard concrete structures: A real scale architectural demonstrator	Hack N.; Dörfler K.; Walzer A.; Wangler T.; Mata-Falcón J.; Kumar N.; Buchli J.; Kaufmann W.; Flatt R.; Gramazio F.; Kohler M.	2020	80
02	Augmented reality gaming in sustainable design education	Ayer S.; Messner J.; Anumba C	2016	80
03	Wireless sensor networks for continuous structural health monitoring of historic masonry towers	Barsocchi P.; Bartoli G.; Betti M.; Girardi M.; Mammolito S.; Pellegrini D.; Zini G.	2020	74
04	Project-based pedagogy in interdisciplinary building design adopting BIM	Jin R.; Yang T.; Piroozfar P.; Kang B.; Wanatowski D.; Hancock C.; Tang L.	2018	67
05	Contribution and obstacle analysis of applying BIM in promoting green buildings	Huang B.; Lei J.; Ren F.; Chen Y.; Zhao Q.; Li S.; Lin Y.	2021	54
06	The need of multidisciplinary approaches and engineering tools for the development and implementation of the smart city paradigm	Andrisano O.; Bartolini L.; Bellavista P.; Boeri A.; Bononi L.; Borghetti A.; Brath A.; Corazza G.; Corradi A.; De Miranda S.; Fava F.; Foschini L.	2018	45
07	Development of 3D underground cadastral data model in Korea: Based on land administration domain model	Kim S.; Heo J.	2017	35
08	Textile reinforced concrete for sustainable structures: Future perspectives and application to a prototype pavilion	Valeri P.; Guaita P.; Baur R.; Fernández Ruiz M.; Fernández-Ordóñez D.; Muttoni A.	2020	33
09	Environmental impact of carbon fibre-reinforced polymer flexural strengthening solutions of reinforced concrete beams	Maxineasa S.; Taranu N.; Bejan L.; Isopescu D.; Banu O	2015	29
10	Toward a sustainable mobility through. A dynamic real-time traffic monitoring, estimation and forecasting system: The RE.S.E.T. project	Torrisi V.; Ignaccolo M.; Inturri G.	2018	26

landscape design, and civil engineering. However, a closer qualitative study indicates that these studies highlight diverse facets of urban sustainability. For instance, studies such as Maxineasa et al. (2015) concentrate on sustainability from an energy-efficiency aspect, underlining the necessity for low-carbon materials, while Hack et al. (2020) examine the aesthetic integration of green areas into urban landscapes. Meanwhile, Torrisi et al. (2018) study urban livability, stressing how pedestrian-friendly streetscapes promote public well-being. This divergence underlines the complex influence of multidisciplinary urban planning, needing a compromise between technological efficiency and human-centered design

Table 2 shows the number of documents published in the ten journals with the most publications records from 2015 to 2024.

The distribution of publications across various nations as in Figure 4 demonstrates a diversified and internationally active research community on the topic of sustainable urban development, notably concerning the synergy between landscape architecture and civil engineering.

Leading the contribution is the United States with 15 documents, highlighting its prominent position in furthering multidisciplinary research. As a worldwide leader

Table 2. The top 10 journals that published the most articles that were identified from Scopus database analysis

No.	Name of the journal/conference proceeding	Number of documents published
01	IOP Conference Series – Earth and Environmental Science	05
02	E3s Web of Conferences	04
03	IOP Conference Series – Material Science and Engineering	04
04	Journal of Cleaner Production	04
05	Sustainability Switzerland	04
06	International Multidisciplinary Scientific Geoconference – Surveying Geology and Mining Ecology Management (SGEM)	03
07	Automation in Construction	02
08	Engineering Construction and Architectural Management	02
09	Heliyon	02
10	Key Engineering Materials	02

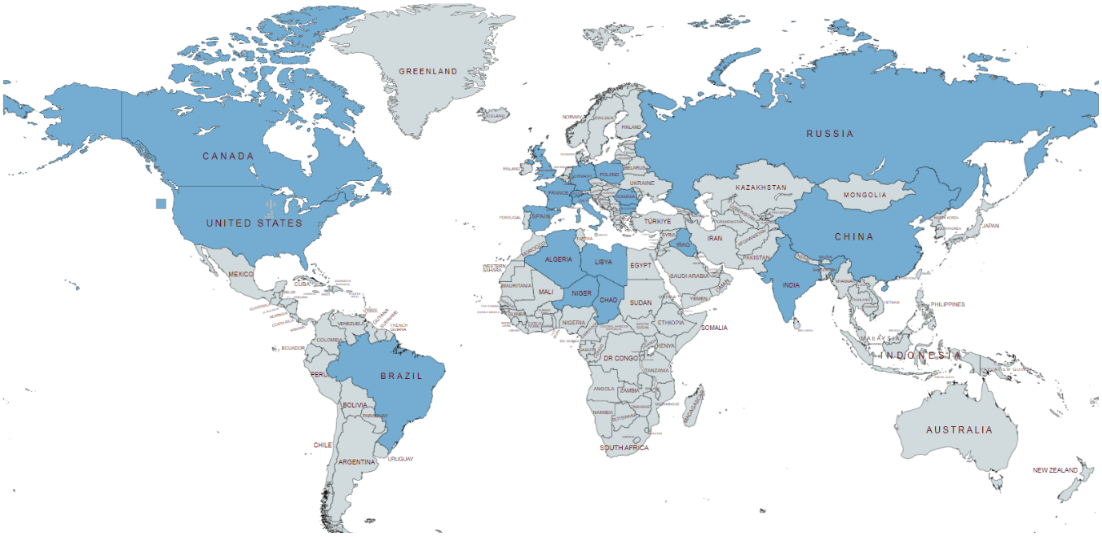

Figure 4. Top 15 countries that published papers in the given research field and indexed in Scopus from 2015 to 2024

in both urban planning and civil engineering advances, the United States' significant contribution demonstrates its continuous commitment to tackling urban sustainability concerns via cutting-edge research and practice. Italy, Romania, and the Russian Federation each contributed 9 papers, showing substantial research efforts in these areas. The substantial representation of European nations, including Germany, Spain, Poland, Switzerland, and the United Kingdom, highlights Europe's major role in encouraging sustainable urban development. These nations, with strong academic and professional networks in both civil engineering and landscape architecture, are actively contributing to the integration of these disciplines to fulfill the rising need for sustainable urban solutions. Brazil's 6 publications indicate the expanding relevance of sustainable urbanization in emerging nations, while China (4 papers) and India (3 documents) reflect the increasing emphasis on tackling fast urban expansion concerns in the global south. Other contributors such as Bulgaria, France, and Iraq, albeit with fewer publications, reflect rising interest in this multidisciplinary topic across diverse geographies. This geographic distribution implies that although some countries dominate the research output, the global character of the subject has fostered contributions from a broad variety of nations, each bringing distinct views and ideas to the table.

The bibliometric comparison between France and Iraq was chosen to demonstrate the gap in research output between developed and developing countries. France, with its long-established urban sustainability rules and substantial university research funding, has a well-documented history of combining landscape design with civil engineering concepts. By contrast, Iraq is an expanding economy where urban sustainability concerns are worsened by post-conflict rebuilding and weak governmental frameworks. This comparison is not meant to equal the two countries in terms of urban development maturity but rather to highlight how various political and economic contexts impact scholarly contributions to sustainable urban planning.

The examination of document distribution by such area shown in Figure 5 demonstrates that the field of sustainable urban development, especially in the context of merging landscape architecture and civil engineering, includes a broad variety of disciplines.

Engineering leads with 31.3% of the total papers, underlining the essential role that civil engineering plays in developing infrastructure that supports sustainable cities. The significance of engineering reflects the technical issues connected with sustainable urban development, such as constructing durable structures, efficient transportation networks, and infrastructure systems that reduce environmental effect. Environmental Science provides 12.5% of the papers, showing the crucial relevance of ecological factors in urban design. The combination of environmental science with engineering and landscape architecture underlines the need for sustainable methods that reduce environmental deterioration and enhance biodiversity. Social Sciences (10.1%) also play a considerable role, demonstrating the rising realization that human behavior, policy, and community participation are key aspects in effective sustainable urban development. Smaller but important contributions come from subjects such as Earth

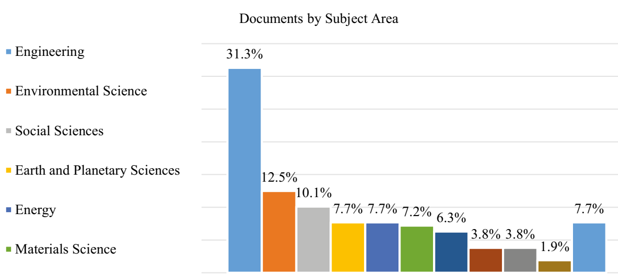

Figure 5. Documents distribution by subject area

and Planetary Sciences (7.7%), Energy (7.7%), and Materials Science (7.2%). These topics concentrate on resource management, energy efficiency, and the use of sustainable materials, all of which are crucial to decreasing the environmental imprint of urban projects. Computer Science (6.3%) helps to improvements in smart city technology and data-driven methodologies that promote efficient urban planning and sustainability aims. Other subject areas, like Business, Management and Accounting (3.8%) and Physics and Astronomy (3.8%), highlight the multidisciplinary character of sustainable urban development, where economic, scientific, and managerial viewpoints are linked to promote long-term sustainability. The "Other" group, accounting for 7.7%, comprises a variety of courses such as Mathematics, Agriculture and Biological Sciences, and Chemistry, among others. These domains, albeit generating fewer publications, contribute essential insights into specialized topics including data analysis, agricultural sustainability within urban contexts, and the chemical processes involved in materials production. The vast variety of topic areas underlines the multidimensional character of sustainable urban development, necessitating contributions from many sectors to handle the difficult issues cities confront in the 21st century.

4.2. Visualization of bibliometric analysis

The keyword co-occurrence network analysis as presented in Figure 6, obtained from 1,153 total keywords, demonstrates that "sustainable development" is the most prevalent phrase, acting as the central hub linking diverse subjects relating to architecture, civil engineering, and environmental sciences.

Major groupings include "architecture," "engineering education," "sustainability," "architectural design," and "urban planning," indicating the major subfields where the synergy between landscape architecture and civil engineering is most obvious. The strong links between "sustainable development" and "architecture" highlight the essential role of architectural design in shaping sustainable urban environments, while the presence of "engineering education" emphasizes the importance of training future professionals to address sustainability challenges. Additionally, new subjects such as "project management", "energy efficiency," "waste management," and "civil engineering" illustrate the rising emphasis on technical and material advances driving sustainable urban development. Keywords like "greenway" and "eco-design" also hint at an increasing interest in integrating natural aspects into urban development. Overall, the network emphasizes both the basic issues and the developing areas of interest within the study field, displaying the multidisciplinary approach necessary to meet the complex difficulties of sustainable urban development. As shown in Table 3, describes the highly co-occurring terms, the number of times happened, and the overall link strength.

The hotspot analysis of the keyword density visualization as shown in Figure 7 highlights major regions of

Table 3. Data on keyword co-occurrence for the selected papers

No.	Name of the journal/ conference proceeding	Number of documents published
01	Sustainable development	1109
02	Architecture	368
03	Engineering education	276
04	Sustainability	266
05	Architectural design	257
06	Urban planning	222
07	Energy efficiency	207
08	Construction	200
09	Project management	174
10	Civil engineering	169

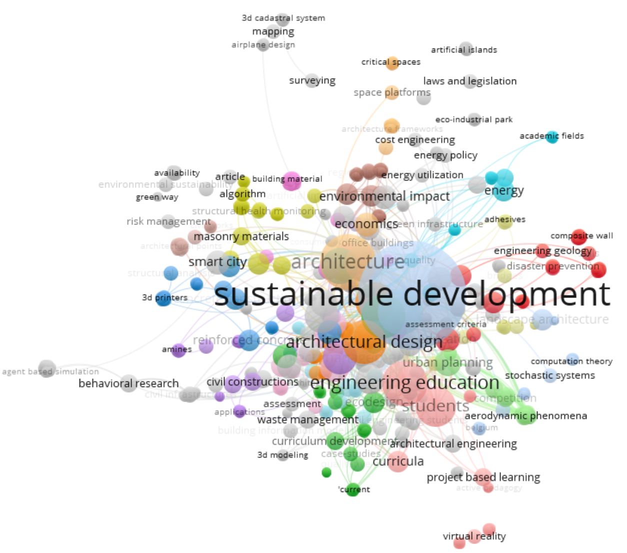

Figure 6. Keyword co-occurrence network visualization by VOS Viewer

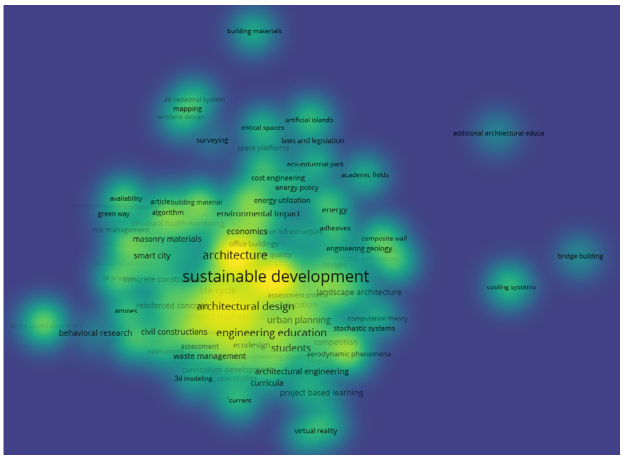

Figure 7. Density visualization of keyword co-occurrence for hotspot identification

intense research activity within the topic of sustainable urban development.

The brightest hotspots, notably around "sustainable development," imply that this notion is the core pillar driving most of the study in the sector. Closely related words such as "architecture," "architectural design," and "engineering education" also occur in dense clusters, demonstrating the strong interdisciplinary character of courses that merge landscape architecture with civil engineering to create sustainable urban solutions. This hotspot analysis clearly illustrates both the well-established themes and the developing subjects that are determining the future direction of sustainable urban development research.

While the bibliometric data gives a quantitative view on the expansion of interdisciplinary research, it is as vital to evaluate these patterns via a qualitative lens. The statistical domination of studies concentrating on energy efficiency and carbon reduction suggests a worldwide research emphasis on climate mitigation techniques. However, fewer studies explicitly address socio-cultural integration in urban landscapes, suggesting a possible research vacuum in the junction of civil engineering, landscape design, and community participation. Furthermore, the high citation rates for European case studies reflect a robust policy-research feedback loop in industrialized countries, but lesser involvement in places like the Middle East and South Asia alludes to limited governmental acceptance of sustainability research results.

5. Discussion

This review article aims to provide a comprehensive analysis of recent research focusing on sustainable urban development and design. As cities around the world face unprecedented challenges related to population growth, environmental degradation, and resource scarcity, innovative approaches are essential for fostering resilience and enhancing the quality of urban life. The studies discussed herein explore a range of topics, including the transformation of industrial parks into positive energy hubs, the thermal performance of buildings, and the integration of building-bridges and platforms to address urban traffic and space limitations. Each study contributes valuable insights into the complex interplay between architecture, sustainability, and urban planning.

The research conducted by Codemo et al. (2024) provides important knowledge into the optimal integration of photovoltaic (PV) systems into landscapes, thereby informing our investigation into sustainable urban development. The research emphasizes the importance of landscape integration in shaping public acceptance of renewable energy technology by analyzing perceptions of solar landscapes. This is especially pertinent to our study inquiry, which aims to investigate integrated strategies for sustainable urban development. Codemo et al. (2024) indicate that while solar (PV) systems are mostly seen as beneficial for the energy transition, their acceptability is significantly influenced by their installation method, with a marked preference for Building-Integrated Photovoltaic (BIPV) solutions over ground-mounted systems. These conclusions are essential for urban planners and landscape architects aiming to harmonize aesthetics, usefulness, and sustainability in urban environments, while also addressing public concerns about land use and biodiversity (Barakat, 2020). The research emphasizes the necessity of integrating technical performance with social considerations in the design and execution of renewable energy infrastructures, highlighting the requirement for multifunctional, well-engineered energy systems to secure social acceptance and align with sustainable urban development objectives (Codemo et al., 2024; Kazancoglu et al., 2023). The study by Kim and Heo (2016) is pivotal in promoting sustainable urban development by integrating landscape architecture and civil engineering with the implementation of a 3D subsurface cadastral data model. This model extends the usual 2D system to handle 3D subsurface features, which is vital for resolving vertical land disputes and assuring appropriate land usage in highly populated metropolitan situations. By precisely mapping and registering subterranean facilities like subways, utilities, and civil engineering projects, the model promotes more effective land administration, which is crucial for sustainable urban planning (Kim & Heo, 2016; Broere, 2015). It enables landscape architects to create surface-level green spaces, parks, and public places without interfering with the spatial requirements of subterranean infrastructures, so guaranteeing that urban environments preserve ecological and aesthetic characteristics while facilitating vital civil projects (Pang, 2020). This integration helps avoid urban sprawl, optimizes land use, and promotes more compact, sustainable communities (Como et al., 2023). By synchronizing subsurface property management with surface-level landscape architecture, this strategy fosters the construction of resilient and ecologically responsible urban places that satisfy the expanding needs of urbanization while preserving the ecological balance (Mielby & Henriksen, 2020).

The results of Hamamcıoğlu-Turan et al. (2024) help to sustainable urban development by giving insights into the architecture and building practices of early Turkish communities on the Urla Peninsula. The research emphasizes the utilization of local resources and the integration of Roman-Byzantine building processes, showing the sustainable practice of material reuse. These results give useful direction for conservation management, allowing current urban planners and architects to rely on historical methodologies that combine cultural heritage preservation with sustainable building practices in contemporary urban growth (Salameh et al., 2021; Coombes & Viles, 2021; Xia et al., 2022). The work by Xing and Xia (2024) underlines the relevance of integrating environmental sensors and 3D point cloud processing in current architectural landscape architecture, contributing greatly to sustainable urban development. By employing environmental sensors to monitor real-time data like as temperature, humidity, and lighting, designers may make educated choices that increase both energy economy and occupant comfort. Additionally, 3D point cloud processing enables for exact integration of structures with their natural surroundings, creating a more harmonic fit between architecture and nature (Xing & Xia, 2024; Urech et al., 2020). These technology improvements not only optimize the design process but also enable the production of more intelligent and ecologically friendly urban areas, encouraging synergy between landscape architecture and civil engineering (Yoffe et al., 2024; Liao et al., 2023b). The article by Chesley et al. (2023) proposes an analytical framework for in-space geoengineering, that presents unique opportunities for climate change mitigation utilizing space-based interventions. This strategy addresses the complexities of large-scale geoengineering operations by focusing on sustainability, reversibility, and practicality, incorporating many factors such as policy, biosphere sustainability, economic viability, and operational issues. Chesley et al. (2023) further highlight how space-based climate remedies, such as the establishment of satellites and orbital infrastructure, could have major effects on the atmosphere of the planet, oceans, and ecosystems, potentially transforming climate mitigation efforts particularly tackling to detrimental issues that present-day climate change has on urban landscape development. Perov et al. (2019) studied the present energy-efficient architecture in Russia. According to the study by Perov et al. (2019), although eco-friendly architecture exists in Russia, its prevalence is substantially lower than in leading nations, mostly owing to a lack of severe regulations and economic incentives. The authors claim for the establishment of a broad eco-friendly architecture structure for public buildings, which might encompass cutting-edge studies from both Russian and global sources, with a call for reforms in education and changes in legislation that encourage the adoption of green technologies. This method might help greatly to sustainable urban development by creating a more robust convergence of landscape architecture and civil engineering in Russia (Yakubov, 2018). According to Carden and Fell (2021), the emergence of Communities of Practice (CoPs) allows professionals to interact across disciplines, which drives the development of Water Sensitive Design (WSD) in South Africa. The research emphasizes the importance of CoPs in promoting social learning, knowledge transfer, and institutional integration, all of which are necessary for implementing WSD at the local level. The authors stress the significance of relating professionals in water management and establishing environments that allow for the transition to water-sensitive cities using examples such as collaborations between academia, government bodies, and professional groups (Van De Meene et al., 2020; Floyd et al., 2014). This study adds to a better understanding of sustainable urban development by demonstrating how landscape architecture and civil engineering must collaborate via CoPs to provide integrated planning and resilient urban water management.

Digital twins and BIM may improve urban sustainability via landscape architecture by allowing for improved design, real-time monitoring, and responsive management of urban green areas and infrastructure (Wang et al., 2019; Deng et al., 2021). According to Fokaides et al. (2022), the use of digital twins and Industry 4.0 technologies such as BIM and smart meters is critical to enhancing the energy efficiency and sustainability of the built environment, particularly in landscape management and design. Digital twins provide virtual representations of actual landscapes that may replicate different scenarios, enabling landscape architects to improve green space layouts, water management systems, and energy-efficient infrastructure prior to deployment (Yang et al., 2022; Ferko et al., 2022; Callcut et al., 2021). BIM generates precise, data-rich 3D models that include environmental issues like energy usage and resource flows into the design process, encouraging environmentally responsible urban planning (Marrero et al., 2020). Umeokafor et al. (2022) identify major challenges to adopting Prevention through Design (PtD) in Nigeria's construction sector, where a lack of knowledge and awareness prevents its implementation. The research finds that designers often lack power over customers, who give little support for PtD, while fear of responsibility and limited legal frameworks compound the problem. His study contributes to sustainable urban development by underlining the need to include safety concerns in design techniques, which might be combined with landscape architecture to produce safer, more resilient urban settings. González et al. (2021) investigate the feasibility of retrofitting residential buildings with ecological rooftop infrastructures, concentrating on F.E.W. (Food, Energy, and Water) structural prototypes. Their findings show that incorporating green roofs and renewable energy systems into existing buildings may improve resource efficiency, lower energy consumption, and increase urban sustainability. By retrofitting roofs with these ecological solutions, the research makes a substantial contribution to urban resilience, which is consistent with landscape architecture's role in building sustainable, multifunctional urban settings (Calheiros & Stefanakis, 2021). This strategy encourages collaboration between civil engineering and landscape architecture by building green infrastructure that promotes both environmental and social sustainability in cities. Dmitruk and Stachańska (2024) explore ways to revitalize post-mining communities by creating useful and visually attractive environments. Their findings underscore the need to maintain these areas' cultural history by converting obsolete industrial infrastructure into recreational amenities such as ski slopes and tourism paths. The authors contend that reviving mining regions may considerably enhance the quality of life in local communities by incorporating sustainable development concepts and encouraging multifunctional land use.

Marabout and Anton (2019) examine pedestrian wind comfort in urban places, with an emphasis on how architectural design and spatial layout impact outdoor microclimatic conditions. Their wind tunnel experiment on the Laser Valley campus demonstrates that specific regions, notably those near cylindrical structures, encounter significant wind speeds, which might cause discomfort for walkers and impair the usefulness of outdoor spaces meant to enhance social cohesion. The research emphasizes the need to combine landscape architecture and civil engineering to handle wind-related concerns in urban planning, ensuring that outdoor areas are both pleasant and inviting to community engagement. Ivanov (2020) emphasizes the substantial problems that border municipalities in Bulgaria and Serbia confront while embracing ecological urbanism. The primary challenges have been a lack of administrative competence, low population levels, and indifference from central authorities during the last two decades, particularly in Bulgarian municipalities. Given these limits, the implementation of ecological urbanism looks to be a mirage rather than a reality. Ivanov (2020) contends that the only practical option for these communities is to seek support via European Union programs and grants. To accomplish sustainable urban growth, stringent administrative capacity is required. Sargentis et al. (2019) introduce a computational tool, 2D-C, to quantitatively assess landscape transformations caused by renewable energy installations, offering an objective alternative to subjective aesthetic evaluations. While the tool provides promising results in analyzing visual changes in landscapes, its current application is limited to specific viewpoints and further data is needed to fully understand its impact on aesthetics. According to Shau et al. (2019), Taiwan's Suhua Highway Improvement Project demonstrates substantial sustainable principles in infrastructure construction. The writers emphasize the project's use of ecological conservation and local architectural elements, which not only reduces environmental effects but also improves the landscape's aesthetic appeal. The unique strategy of changing concrete compositions to cut carbon emissions by 34–43% demonstrates the project's dedication to sustainability and provides useful insights for future civil engineering projects targeted at sustainable urban development. Danilova and Kurik (2023) underlines the necessity of establishing a local green frame in St. Petersburg to improve urban sustainability by attracting beneficial insects. The authors suggest a complete set of landscape solutions that include ecological, botanical, and soil science concepts, which are critical for promoting biodiversity in urban contexts. Their methodology, which includes innovative tools such as the Ecological Zoning Scheme and the Landscaping Matrix, emphasizes a participatory design approach that involves residents in the process, making it an important contribution to our understanding of sustainable urban development and the role of landscape architecture in creating resilient urban ecosystems (Malmborg et al., 2022).

Norenkov and Krasheninnikova (2020) address the need for a universal model of urban design that conforms with sustainable development principles, notably in the context of "smart garden cities." Their findings highlight the significance of incorporating human and humanitarian universals into urban design to build unified ensemble spaces that represent the distinct qualities of each historical setting. The authors offer a socio-anthropological synarchiotectonics framework that uses deductive and inductive approaches to help in modeling and building urban settings that are not only aesthetically beautiful but also useful and sustainable. According to Vijayan et al. (2021), thermal performance plays an important part in improving building sustainability. The authors emphasize that appropriate thermal design is critical for preserving interior comfort while lowering carbon emissions and energy consumption in a variety of building types, including residential, commercial, and educational buildings. Their results indicate that novel solutions, such as aerogel glazing and fine-tuning HVAC systems, may dramatically enhance thermal efficiency, resulting in higher indoor air quality and occupant comfort. This study offers helpful knowledge into incorporating thermal performance techniques into the planning and design stages of sustainable urban development, demonstrating how landscape architecture and civil engineering may collaborate to produce energy-efficient habitats (Thani et al., 2012). Palumbo et al. (2019) look at the shift from sustainable to smart city frameworks, highlighting the crucial role of metropolitan districts in accomplishing sustainability objectives. They find a dearth of adequate environmental indicators for measuring the built environment, pointing out that urban sustainability evaluation methods are more advanced than smart city frameworks. To address this, the authors use a simplified Life Cycle Assessment (LCA) to assess the Bolognina neighborhood's retrofitting intervention, with a focus on buildings, energy, water, and trash. Their results underscore the need to build complete sustainability frameworks that include social elements, as well as the requirement for harmonization across the functional units utilized in evaluations. Palumbo et al. (2019) point out that present procedures often depend on subjective approaches, implying that further research is required to develop methods and build a more rigorous framework for urban sustainability assessments.

Anastasovski (2022) investigates the feasibility of converting industrial parks into Positive Energy Industrial Parks (PEIPs) via six dimensions: legislative frameworks, socioeconomic variables, management practices, technological considerations, building features, and sustainability. The research cites barriers, such as the necessity for strong rules and regulations to promote sustainable development and the need to implement best practices from positive energy districts (Anastasovski, 2022; Wang et al., 2023). It highlights the establishment of centralized governmental agencies to handle environmental and community issues, as well as the fact that high prices discourage renewable energy adoption (Khalid et al., 2021). Zabalueva and Zakharov (2020) highlight the importance of creating bridges and platforms to solve two major urban challenges which are traffic congestion and a lack of suitable space for development. They argue that combining building structures with bridges might improve urban traffic networks and generate early cash by leasing valuable building areas to investors. This unique technique uses existing infrastructure, changing access corridors into places for parks, sports fields, and gardens, improving the urban environment. The authors emphasize the significance of securing private contributions to accelerate bridge building since present state funding often results in protracted project timetables. They argue that the creation of inhabited bridges that handle both pedestrian and vehicular traffic is critical for sustainable urban design, underlining the importance of investor interest in reducing the financial load on municipal budgets.

In merging these varied viewpoints, this study's unique contribution is in charting a complete framework where civil engineering and landscape architecture act as coequal partners in urban planning. This concept goes beyond identifying ecological factors; it mandates that sustainability must be systematically "engineered" into infrastructure at every level, from policy formulation and educational curriculum to on-site execution and long-term management. The study also underlines the continuous need for practical case studies and pilot projects that test how integrated systems perform in varied urban settings, especially in places with low resources or varying policy regimes. In accordance with Palumbo et al. (2019), findings recommend future efforts to create and standardize measures for measuring holistic results. These measurements should reflect not just financial savings or structural performance but also social well-being and ecological health factors crucial to the overall success of integrated design.

In conclusion, the key contribution of this research is the comprehensive understanding that while existing literature emphasizes the value of interdisciplinary collaboration, relatively few studies offer clear, practical pathways for uniting landscape architectural expertise with civil engineering solutions at scale. Explaining the policies, educational reforms, and technology tools essential for this synergy, this research offers a path for practitioners and legislators wanting to construct genuinely sustainable, resilient urban settings.

6. Conclusions

The combination of landscape architecture and civil engineering is essential to sustainable urban development. As urban populations expand and climate-related concerns escalate, cities globally must adopt design and planning strategies that meet the requirements of efficiency, resilience, and environmental stewardship. This research, grounded in the critical review of 23 scholarly articles, emphasizes how leveraging the complementary attributes of both fields can help tackle complex urban issues ranging from degradation of the environment and global warming adaptation to traffic jams and geographic constraints while producing vibrant, inclusive, and future-ready environments.

A major conclusion of this research is that effective urban sustainability needs a mix of infrastructure resilience and ecological sensitivity. Civil engineering imparts crucial technical expertise for the construction of roads, bridges, water supply systems, and other fundamental infrastructure. On the other, landscape architecture guarantees that these infrastructure components are integrated smoothly with natural processes and human well-being in mind. The development of permeable pavements that effectively control rainwater and mitigate flood risk, and the construction of connected green corridors that enhance biodiversity, demonstrate significant potential in the integration of these two domains. Incorporating ecological design concepts into infrastructure construction not only enhances urban aesthetics but also alleviates adverse effects of urbanization, like the urban heat island phenomenon and the fast depletion of green areas.

Digital technology has emerged as a major driver in deepening this synergy. Instruments like Geographic Information Systems (GIS), BIM, and Digital Twin simulations enable planners and engineers to foresee and illustrate the enduring consequences of various design decisions. For example, sophisticated modeling software can forecast the thermal effects of densely constructed areas, aiding in judgments on the optimal integration of green roofs, vegetated walls, or water features to mitigate temperatures and enhance air quality. Similarly, real-time data from IoT sensors allow urban managers to understand how infrastructure is working under stress, whether it is from heavy rains or high traffic loads and then plan interventions in ways that safeguard ecological networks and assure the well-being of residents. By integrating comprehensive civil engineering assessments with cohesive landscape design, municipal authorities, and private developers may advance toward data-driven, unified solutions that reduce resource consumption, improve resilience, and promote social fairness.

Despite these achievements, institutional, educational, and policy-related challenges exist. The literature analysis highlights a trend of policy fragmentation: sustainable design principles in one sector may be undermined by antiquated regulations in another, hindering coherent large-scale results. In many urban situations, civil engineering and landscape architecture remain segregated, with each profession focused on its criteria for success. Civil engineers may concentrate on structural strength and financial efficiency, but landscape architects prefer to focus on aesthetics, ecological balance, and user experience. This mismatch may result in disconnected projects where infrastructure overlooks local ecosystems, or green areas remain impracticable owing to the restrictions of existing utilities and transportation networks.

Cross-disciplinary education appears as a significant component for overcoming these gaps. Academic programs in landscape architecture might combine sophisticated infrastructure planning modules, whereas civil engineering curricula could provide required courses on ecological design, sustainability, or urban agriculture. Such an educational approach trains the next generation of professionals to work together, ensuring that engineers understand how design criteria impact ecological processes, and that landscape architects comprehend the technical underpinnings of developing solid infrastructure. Joint studios, multidisciplinary workshops, and joint research projects are effective methods to emulate real-world partnerships, equipping future graduates to traverse the intricacies of urban systems holistically. Furthermore, policy support is another crucial driver in attaining integrated urban development. Sustainable urban planning techniques frequently rest on political will and properly established rules. A unified policy framework that facilitates early-stage cooperation among engineers, architects, ecologists, and community stakeholders guarantees that resources are distributed efficiently and that projects satisfy community requirements successfully. Incentives–such as grants, tax incentives, or quicker permitting processes–can also encourage private developers to use green infrastructure, renewable energy systems, and human-centered designs. On the international level, adherence to standards like the United Nations SDGs and the New Urban Agenda may mobilize municipal and regional governments to implement legislation that supports multidisciplinary approaches to infrastructure and landscape management.

Economic factors further underline the benefits of combining landscape design with civil engineering. While creating environmentally friendly infrastructure may entail early expenses, research has shown that these investments frequently pay off in the long term via decreased energy consumption, lower healthcare costs, higher property values, and greater climate resilience. For example, incorporating natural flood defense systems–like wetlands or restored riverbanks–can be more cost-effective over time than depending simply on large-scale concrete barriers. Likewise, urban forests and linked greenways may dramatically enhance air quality, decrease building energy use by regulating local temperatures, and raise real estate appeal, creating wider advantages for people, investors, and governments. When local economies prosper owing to an enhanced urban environment, the social and cultural fabric of the city improves, further boosting resilience and quality of life.

Social involvement stands out as an important but frequently ignored part of sustainable urban development. Urban planning methods that include communities in co-design techniques empower residents and strengthen local identity. Public places developed with direct participation from residents tend to be more inclusive and better used, boosting social cohesiveness and placemaking. The co-creation of green infrastructure such as community gardens, pocket parks, or rooftop farms helps educate communities about environmental stewardship and creates common ownership of public assets. This inclusive approach is particularly crucial in economically disadvantaged communities, where a lack of involvement in planning choices may perpetuate environmental injustices and health inequities. By implementing participatory tactics in civil engineering and landscape architectural processes, urban leaders can guarantee that growth and development benefit everyone.

As both research and practice improve, it becomes obvious that the combined skills of landscape architects and civil engineers can convert the difficulties of urbanization into accelerators for sustainable growth. This research, via the integration of diverse academic views, shows the great potential of multidisciplinary cooperation and the real advantages it may offer to communities worldwide. The results imply that continuing study, legislative backing, and technology innovations will further enhance these advantages, opening the path for communities that exemplify regenerative principles. In the years ahead, the responsibility of urban planners, politicians, and practitioners is to strengthen these relationships, enhance integrated frameworks, and invest in scalable solutions that enrich our cities ecologically, socially, and economically. By doing so, the footprint that we leave for generations to come will be not only livable and productive but also deeply regenerative and equitable as a testament to the power of synergy between the art of landscape architecture and the science of civil engineering in shaping a truly sustainable urban future.

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INTEGRUOTAS POŽIŪRIS Į DARNIĄ MIESTŲ PLĖTRĄ: KRAŠTOVAIZDŽIO ARCHITEKTŪROS IR STATYBOS INŽINERIJOS SINERGIJA

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Santrauka

Šiame tyrime nagrinėjama besivystanti kraštovaizdžio architektūros ir statybos inžinerijos sinergija darnios miestų plėtros kontekste. Tyrimu siekiama išanalizuoti, kaip šios daugiadisciplinės profesijos galėtų kartu spręsti miesto urbanistinius iššūkius, kartu užtikrindamos ilgalaikį aplinkos, socialinį ir ekonominį tvarumą. Taikant PRISMA metodą, tyrime išsamiai peržiūrėti antriniai duomenys iš *Scopus* duomenų bazės, nustatyti 23 susiję leidiniai, paskelbti 2015–2024 m. Tyrime nurodomi pagrindiniai integracijos būdai, kliūtys ir naujos tendencijos, darančios įtaką įvairių disciplinų bendradarbiavimui. Rezultatuose pabrėžiamos pagrindinės sėkmingo tarpdisciplininio bendradarbiavimo kliūtys, įskaitant politikos fragmentiškumą, netinkamą tarpdisciplininį švietimą ir technologijų pritaikymo problemas. Be to, tyrime pabrėžiama teorinių pagrindų ir praktinių atvejų tyrimų sujungimo svarba siekiant pagilinti žinias apie integruotos miestų plėtros metodus. Pateikiant išsamią literatūros analizę, šis tyrimas prisideda prie gilesnių žinių apie tarpdisciplininius miestų planavimo sprendimus ir suteikia svarbių įžvalgų politikos formuotojams, mokslininkams ir praktikams, siekiantiems atsparios ir pritaikomos miestų aplinkos.

Reikšminiai žodžiai: tvarumas, miestų planavimas, kraštovaizdžio architektūra, civilinė inžinerija.