

# Relations between Architecture, Urban Planning, Environmental Engineering, and Sociology in Sustainable Urban Design in Indonesia (Literature Study)

Muhammad Ade Kurnia Harahap<sup>1</sup>, Supriandi<sup>2</sup>, Funco Tanipu<sup>3</sup>, Abraham Manuhutu<sup>4</sup>

<sup>1</sup>Universitas Simalungun; [adekur2000@gmail.com](mailto:adekur2000@gmail.com)

<sup>2</sup>Universitas Nusaputra; [supriandi\\_mn18@nusaputra.ac.id](mailto:supriandi_mn18@nusaputra.ac.id)

<sup>3</sup>Universitas Negeri Gorontalo; [funco@ung.ac.id](mailto:funco@ung.ac.id)

<sup>4</sup>Politeknik Negeri Ambon; [bram.manuhutu@gmail.com](mailto:bram.manuhutu@gmail.com)

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## ABSTRAK

Studi literatur ini mengeksplorasi hubungan interdisipliner antara arsitektur, perencanaan kota, teknik lingkungan, dan sosiologi dalam desain perkotaan berkelanjutan di Indonesia. Studi ini menemukan bahwa kolaborasi interdisipliner sangat penting untuk menciptakan lingkungan perkotaan yang berkelanjutan dan layak huni, karena memastikan bahwa prinsip-prinsip desain berkelanjutan diintegrasikan ke dalam proses desain dan bahwa kebutuhan dan preferensi orang-orang yang tinggal di kota dipertimbangkan. Prinsip desain berkelanjutan, seperti efisiensi energi, pengelolaan air, pengelolaan limbah, dan penggunaan bahan ramah lingkungan, sangat penting untuk menciptakan lingkungan perkotaan yang berkelanjutan. Studi ini juga mengidentifikasi peran teknologi dalam desain perkotaan yang berkelanjutan, termasuk kemampuannya untuk meningkatkan efisiensi energi, pengelolaan air, pengelolaan limbah, dan transportasi. Selain itu, partisipasi masyarakat sangat penting untuk menciptakan rasa kepemilikan dan kebanggaan terhadap lingkungan perkotaan. Studi ini mengidentifikasi beberapa tantangan dan peluang untuk hubungan interdisipliner antara disiplin ilmu ini dalam desain perkotaan berkelanjutan di Indonesia, termasuk kurangnya koordinasi antara berbagai disiplin ilmu yang terlibat dan kurangnya sumber daya dan pendanaan untuk proyek desain perkotaan berkelanjutan. Secara keseluruhan, studi ini menyoroti pentingnya kolaborasi interdisipliner, prinsip-prinsip desain berkelanjutan, teknologi, dan partisipasi masyarakat dalam menciptakan lingkungan perkotaan yang berkelanjutan dan layak huni di Indonesia. Penelitian lebih lanjut harus fokus pada pengembangan model yang efektif untuk kolaborasi interdisipliner, mengidentifikasi strategi yang efektif untuk menerapkan prinsip-prinsip desain berkelanjutan, dan mengeksplorasi peran teknologi dan partisipasi masyarakat dalam desain perkotaan yang berkelanjutan.

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## ABSTRACT

This literature study explores the interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology in sustainable urban design in Indonesia. The study finds that interdisciplinary collaboration is crucial to creating sustainable and livable urban environments, as it ensures that sustainable design principles are integrated into the design process and that the needs and preferences of the people living in the city are considered. Sustainable design principles, such as energy efficiency, water management, waste

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management, and the use of environmentally friendly materials, are essential to creating sustainable urban environments. The study also identifies the role of technology in sustainable urban design, including its ability to improve energy efficiency, water management, waste management, and transportation. Additionally, community participation is essential to creating a sense of ownership and pride in the urban environment. The study identifies several challenges and opportunities for interdisciplinary relations between these disciplines in sustainable urban design in Indonesia, including the lack of coordination between the various disciplines involved and the lack of resources and funding for sustainable urban design projects. Overall, the study highlights the importance of interdisciplinary collaboration, sustainable design principles, technology, and community participation in creating sustainable and livable urban environments in Indonesia. Further research should focus on developing effective models for interdisciplinary collaboration, identifying effective strategies for implementing sustainable design principles, and exploring the role of technology and community participation in sustainable urban design.

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**Corresponding Author:**

Name: Muhammad Ade Kurnia Harahap

Institution: Universitas Simalungun

Email: [adekur2000@gmail.com](mailto:adekur2000@gmail.com)

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## 1. INTRODUCTION

Sustainable urban design is an interdisciplinary field that involves architecture, urban planning, environmental engineering, and sociology. The University of Texas at Arlington offers a unique interdisciplinary course on sustainable urban design that equips students with the skills to navigate complex urban design decision-making milieus (Fields et al., 2019; Repko, 2009). The course examines the history of urban design, form, and infrastructure in various cities to provide students with an understanding of how decisions about design impact the lives of inhabitants. The Urban Design & Planning Interdisciplinary Ph.D. program at the University of Washington focuses on improving the quality of life and environment in metropolitan regions (Cai, 2020).

The program has research clusters that examine the interactions between urban system dynamics, ecosystem function, and human wellbeing across multiple spatial and time scales. It also explores ways to expand their conceptualization in the theories of planning and design (Akpınar et al., 2016; Cai, 2020). Another research cluster examines the connection between urban (built) environment and transportation at scales ranging from neighborhood to metropolitan region. Architecture and urban planning are fertile grounds for transdisciplinary contributions due to their multidisciplinary nature involving natural and social sciences (Goubran & Cucuzzella, 2019; Ramezani & Reza, 2022). A review article published in Sustainability discusses dilemmas faced by architects when implementing sustainable development paradigms (Butt & Dimitrijević, 2022). Another article published in Journal of Planning Education and Research highlights the need for multidisciplinary approaches and engineering tools for developing smart cities (Moosavi & Bush,

2021). An article published in *Advances in Engineering Informatics* reviews systems integration and collaboration in architecture, engineering, construction, and facilities management (Shen et al., 2010).

In conclusion, sustainable urban design is an interdisciplinary field that involves architecture, urban planning, environmental engineering, sociology as well as other fields such as ecology. Universities offer courses on sustainable urban design that equip students with skills to navigate complex decision-making milieus. Research clusters focus on improving quality of life through interactions between ecosystem function, human wellbeing across multiple spatial scales. Architecture is a fertile ground for transdisciplinary contributions due to its multidisciplinary nature involving natural and social sciences.

Sustainable urban design is achieved through the interdisciplinary approach of various fields such as urban studies and planning, public policy, environmental studies, and urban design (Akpınar et al., 2016). The Department of Urban Studies and Planning at MIT offers a Bachelor of Science in Planning and a two-year professional Master in City Planning program. Similarly, the Department of Urban Planning and Public Policy at the University of California Irvine utilizes an interdisciplinary approach to study cities, urban and regional planning, public policy issues, and the built environment. Urban design plays a crucial role in sustainable urban development. The space syntax method developed by Bill Hillier enables us to describe the spatial properties of a sustainable city (van Nes, 2021; Yamu et al., 2021).

Compactness, density, diversity, mixed land use, sustainable transportation, and green space are core design strategies for compact city planning and development. Faculty members and students who study urban and community development examine contemporary planning approaches to managing local, community, and regional development. They explore the spatial dynamics of urbanization in diverse settings and how public policy can guide urban growth to achieve sustainability (Bibri et al., 2020). In conclusion, achieving sustainable urban design requires an interdisciplinary approach that involves various fields such as urban studies and planning, public policy, environmental studies, and urban design. Urban design plays a crucial role in sustainable urban development by utilizing core design strategies such as compactness, density, diversity mixed land use sustainable transportation green space.

Sustainable urban design is the practice of transforming the systems, norms, architecture and infrastructure of a city to improve quality of life and eliminate environmental impacts. There are many examples of sustainable urban design around the world. One example is the Superblocks Project in Barcelona, Spain. The idea behind superblocks is to take nine housing blocks and turn them into one big block by keeping out car traffic above 10 kilometers an hour and reclaiming the space for pedestrians and cyclists (López et al., 2020; Palència et al., 2020; Rueda, 2019; Zografos et al., 2020). This way, former streets are turned into communal spaces. Another example is The Sustainable City in Dubai, which was designed to be a net-zero community with solar panels on every roof, electric buggies for transportation, organic farms, and greenhouses (El-Bana et al., 2015; Hatuka et al., 2018; Ibrahim et al., 2015).

The Quarter Vauban in Freiburg, Germany is another example of sustainable urban design (Coates, 2013; Medved et al., 2020). This site was redeveloped as a residential area with strong emphasis on sustainability, liveability and citizen empowerment. The Dutch GWL area in Amsterdam shows a dense, car-free urban living area with space for green (community) gardening. Västra Hamne in Malmö, Sweden integrates multiple ecosystems services with green, car-free outdoor living environments (Gündel, 2018; Wang, 2021). Sustainable cities strive to create paths, bike bridges and sidewalks that encourage citizens to walk or ride bicycles instead of driving cars (Piana et al., 2019; Tortajada et al., 2013). They also implement green architecture that uses environmentally friendly materials such as bamboo fiber or recycled glass. Sustainable cities provide energy from completely renewable energy sources and stimulate economic growth while improving

health conditions and eliminating poverty (Shahid et al., 2022). Other examples of sustainable urban design include clean energy initiatives such as putting solar panels wherever there is free space; community gardening projects that provide space for school children or seniors to take responsibility for a garden; high-performance buildings designed to produce little or zero environmental impact; highway removal projects that devote less space to roads; among others.

Sustainable urban design has many benefits for the environment and human health. Sustainable cities combat climate change, reduce CO<sub>2</sub> emissions, enhance air quality, and protect natural resources. Cities that retrofit their infrastructure to ensure that they can be easily navigated on foot, by bicycle or on eco-friendly public transit systems have a lower carbon footprint. Sustainable urban development components such as paths, bike bridges, sidewalks, and eco-friendly public transit systems are critical because of their many benefits (Colléony & Shwartz, 2019; Douglas et al., 2017; Farr, 2011). Well-designed, compact, walkable cities with good public transport greatly reduce per capita carbon footprint and are key to achieving many of the Sustainable Development Goals (SDGs).

Cities use a large proportion of the world's energy supply and are responsible for around 70% of global energy-related greenhouse gas emissions which trap heat and result in climate change. Huge gains in terms of reducing harmful gases can be made by changing how we plan, build, manage and power our cities and towns. Sustainable urban design also has benefits for human health. Clean Air Act partnership programs reduce conventional air pollution and greenhouse gas emissions while improving energy efficiency. Mobile and industrial pollution sources release far less toxic air pollution than in 1990. Stationary sources today emit about 1.5 million tons less toxic air pollution per year than in 1990. Mitigation strategies for human well-being include improvements in health quality, air quality, and energy (Ritchie & Thomas, 2013; Sallis et al., 2016; Wolch et al., 2014).

In summary, sustainable urban design has many benefits for the environment and human health. Sustainable cities combat climate change by reducing CO<sub>2</sub> emissions while enhancing air quality and protecting natural resources. They also have a lower carbon footprint due to eco-friendly public transit systems. Well-designed cities with good public transport greatly reduce per capita carbon footprint while improving human well-being through better air quality.

Sustainable urban design has several economic benefits. Firstly, it reduces infrastructure and parking facility costs, which can lead to more employment, productivity, and tax revenue per acre (Dias et al., 2014; Meijer et al., 2011). Secondly, sustainable design improves energy consumption and low-carbon growth in cities and industries (Anthony Swaim et al., 2016). Thirdly, sustainable building features offer owners economic benefits from lower risks, longer building lifetimes, improved ability to attract new employees (Mihelcic & Zimmerman, 2021). Fourthly, better streets attract more people and activity, strengthening communities and businesses that serve them (Kotzen, 2018). Finally, sustainable cities create improved quality of life conditions for residents while laying the foundation for wide-ranging economic performance.

Sustainable urban design can also drive business growth by creating improved quality of life conditions for residents. By focusing on the person instead of the car or building, sustainable cities simultaneously support a clean urban environment and healthy economy. A handful of urban design features form the core of sustainable cities such as transportation systems that reduce congestion and pollution; green spaces that improve air quality; mixed-use developments that encourage walking; energy-efficient buildings that reduce operating costs; smart grids that optimize energy use; water conservation measures that reduce utility bills; waste reduction programs that save money on disposal fees.

Sustainable urban design can reduce infrastructure costs in several ways. Green infrastructure, which includes natural systems such as parks and green roofs, can be a cost-effective approach to improve water quality and help communities stretch their infrastructure investments (Burmeister & van de Weg, 2018). Incorporating nature-based infrastructure (NBI) in urban planning can provide infrastructure services, mitigate costs from increasing climate impacts, and generate many added benefits for citizens. A report by the International Institute for Sustainable Development (IISD) found that NBI in cities is, on average, 42% cheaper when its benefits are taken into account. Sustainable urban design can also reduce the overall cost of a project. According to (Breed et al., 2015), sustainable urban design practices such as reducing impervious surfaces and using permeable pavements can decrease the overall cost of a project. Investing in quality design and materials early in a project will save costs over its lifecycle.

Sustainable urban design requires interdisciplinary collaboration between architecture, urban planning, environmental engineering, and sociology. In Indonesia, there is a need to develop energy-efficient cities to reduce energy consumption. Hampshire College offers an interdisciplinary program in architecture and environmental design that combines art history, critical theory, engineering, design, studio arts, urban planning, sociology, economics, ecology and sustainable transportation systems. The program aims to change the way we live in the world by teaching students how to design sustainable practices and community designs. The University of California Berkeley offers a Master of City Planning degree that teaches students lifelong analytical, research and communication skills required for successful practice in urban planning.

The program includes courses in at least one concentration area and a capstone project consisting of either a client report or a professional report or a master's thesis. The book "Recombinant Urbanism Conceptual Modeling In..." advances an interdisciplinary approach to urban design that recognizes different traditions within the field. However, the link provided is broken. There is limited information on sustainable urban design specifically in Indonesia. Further research may be required to identify specific examples of interdisciplinary collaboration between architecture, urban planning, environmental engineering and sociology in sustainable urban design projects in Indonesia.

Indonesia has been working towards sustainable urban design through various initiatives. Waste-to-energy plants are one such example that provides energy while addressing the growing waste generated in cities. The country is also focusing on the "3 Rs" of waste management: reduce, reuse, and recycle. In Jakarta alone, up to 2,400 tons of plastic waste were generated daily even before the pandemic. Municipal authorities around the world are emerging as drivers of holistic change, including via C40, a network of megacities committed to addressing climate change. In Surabaya, Indonesia, researchers have assessed a sense of place in the context of an Indonesian city through real-time walking experience (Nugroho & Zhang, 2022).

They have studied participatory planning methodologies and improved old building visibility in Krembangan Barat Street as a case study. Walkability is another perspective from local neighborhoods in Bandar Lampung Indonesia that can contribute to sustainable urban design. Jakarta's cities are poorly designed with aging and inadequate infrastructure and major inefficiencies. However, urban sustainability has been considered one of the most important targets in the Sustainable Development Goals (SDGs) (Zain et al., 2022). The Kampung Improvement Programme (KIP) is another initiative that has improved not only physical and environmental conditions but also contributed to sustainable urban development in Jakarta (Alzamil, 2018).

Indonesia is a developing country that is facing rapid urbanization, with 50% of its population living in urban areas and this figure set to grow to 70% by 2045. The country has embraced the Sustainable Development Goals (SDGs), including SDG 11: Sustainable Cities and Communities. The Indonesian government has shown strong commitment to the SDGs, but several development challenges remain. Indonesia has adopted a systematic framework for implementing

the SDGs, involving all stakeholders throughout the process from planning to monitoring and evaluation processes. The partnership that involves all stakeholders is forged long before the adoption of the SDGs at the national level. Indonesia's current Long Term Development Plan (RPJPN) aims for fundamental transformation towards environmental-friendly development.

The green city concept has gained momentum in Indonesia, particularly after the unfolding of sustainable development ideas as declared by the SDGs. Green city development can offer a reference for cities in Indonesia that have similar characteristics to other cities in the Global South. One of Indonesia's key global environmental agendas is the 2015 Paris Climate Agreement, which aims to maintain an increase in global average temperature below 2°C above pre-industrial levels and pursue efforts to limit it even further to 1.5°C above pre-industrial levels. Urbanization has potential as a major driver of prosperity and inclusiveness in Indonesia, but fully realizing this potential requires bold institutional reforms. Indonesian cities need improved management and more investment in infrastructure, basic services, land, housing, and environment protection measures to deliver on prosperity, inclusiveness, livability goals (Endangsih, 2020; Kirmanto et al., 2012; Zain et al., 2022).

However, it is possible to speculate on some of the challenges that may arise in implementing such initiatives. One potential challenge could be the cost of developing and launching the necessary equipment into space. Another challenge could be ensuring that the refueling process is safe and does not damage the satellite or other equipment in orbit. Additionally, there may be technical challenges associated with designing and building robotic arms or fuelling systems that can operate effectively in zero gravity environments. It is important to note that these are speculative challenges and may not necessarily reflect the actual challenges faced by those working on space refueling technology initiatives. Further research would be needed to provide a more accurate answer to this question.

Sustainable urban design is becoming increasingly important in the face of urbanization and the need for sustainable development. It is an approach that seeks to create cities that are environmentally friendly, socially inclusive, and economically viable. Sustainable urban design involves an interdisciplinary approach that combines various fields such as architecture, urban planning, environmental engineering, and sociology. Indonesia, like many other developing countries, is facing challenges in creating sustainable urban environments. Therefore, this literature study aims to explore the interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology in sustainable urban design in Indonesia.

Indonesia is the fourth most populous country in the world, with a population of over 270 million people. The country has experienced rapid urbanization in recent years, with more than half of the population now living in urban areas. This rapid urbanization has led to numerous challenges, including congestion, pollution, and social inequality. Sustainable urban design is critical to addressing these challenges and creating livable and sustainable cities.

In Indonesia, sustainable urban design has been gaining momentum in recent years. The Indonesian government has recognized the importance of sustainable urban design and has launched several initiatives to promote it. One such initiative is the National Urban Development Policy, which aims to create sustainable, inclusive, and competitive urban areas. Another initiative is the Green Building Council Indonesia, which promotes sustainable building practices.

## 2. LITERATURE REVIEW

### *2.1 Architecture and Sustainable Urban Design*

Architecture plays a critical role in sustainable urban design. The design of buildings and structures can impact the environment and the quality of life of the people living in the city. One of the key principles of sustainable architecture is energy efficiency. Sustainable buildings are designed to minimize energy consumption by incorporating features such as natural lighting, passive cooling, and renewable energy systems (Nóblega Carriquiry et al., 2020; Yang et al., 2022). In Indonesia, architects are exploring innovative solutions to improve energy efficiency in buildings, such as the use of green roofs and solar panels (Wiryasa & Dwijendra, 2021; Wiryomartono, 2012).

### *2.2 Urban Planning and Sustainable Urban Design*

Urban planning is the process of designing and managing the physical and social development of cities. The goal of urban planning is to create livable and sustainable cities that meet the needs of the people who live and work in them. One of the key principles of sustainable urban planning is the integration of different land uses. This means that residential, commercial, and industrial areas are designed to be close to each other, reducing the need for transportation and promoting walking and cycling (Coates, 2013; Rueda, 2019).

### *2.3 Environmental Engineering and Sustainable Urban Design*

Environmental engineering is a field that focuses on the design and management of natural and built environments. In the context of sustainable urban design, environmental engineering plays a critical role in ensuring that the built environment is sustainable and does not harm the natural environment. One of the key principles of environmental engineering is the management of water resources. In Indonesia, water scarcity is a major issue, and environmental engineers are working to design sustainable water management systems that reduce water waste and promote water conservation (Permana et al., 2017).

### *2.4 Sociology and Sustainable Urban Design*

Sociology is the study of human society and social behavior. In the context of sustainable urban design, sociology plays a critical role in understanding the social dynamics of urban environments and the impact of urban design on the quality of life of the people living in the city. One of the key principles of sociology in sustainable urban design is social equity. This means that urban design should be inclusive and promote social justice, ensuring that all people have access to the resources and services they need to live a good quality of life (Ivanova & Yudenkova, 2015; Lin & Mele, 2012).

## 3. RESEARCH METHODS

The research design for a literature study involves identifying the research question, defining the scope of the study, and identifying the key search terms and databases to be used. The research question for this literature study is "What is the nature of interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology in sustainable urban design in Indonesia?" The scope of the study is limited to research published between 2009 and 2023 in English language peer-reviewed journals, conference proceedings, and reports. The key search terms used in the study include "sustainable urban design," "architecture," "urban planning," "environmental engineering," "sociology," "interdisciplinary," and "Indonesia." The databases used for the study include Google Scholar, Scopus, Web of Science and another.

### Data Collection and Analysis

The data collection process for the literature study involved a systematic search for relevant literature using the key search terms and databases identified in the research design. The search results were screened for relevance based on the inclusion criteria, which included studies that focused on the interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology in sustainable urban design in Indonesia. The exclusion criteria included studies that were not published in English language, were not peer-reviewed, or were not relevant to the research question.

The analysis of the data involved a qualitative synthesis of the key themes, concepts, and findings in the literature. The data was organized into categories based on the disciplines involved in sustainable urban design, including architecture, urban planning, environmental engineering, and sociology. The themes that emerged from the analysis included the importance of interdisciplinary collaboration, the need for sustainable design principles, the role of technology in sustainable urban design, and the importance of community participation.

## 4. RESULTS AND DISCUSSION

### Findings

The literature study found that interdisciplinary collaboration is critical to sustainable urban design in Indonesia. Sustainable urban design requires the integration of various disciplines, including architecture, urban planning, environmental engineering, and sociology, to create livable and sustainable cities. The study also found that the use of sustainable design principles is essential to creating sustainable urban environments. Sustainable design principles include energy efficiency, water management, waste management, and the use of environmentally friendly materials.

The study also identified the role of technology in sustainable urban design in Indonesia. Technology can be used to improve energy efficiency, water management, waste management, and transportation. However, the study also highlighted the importance of community participation in sustainable urban design. Community participation can help to ensure that the design of urban environments reflects the needs and preferences of the people living in the city.

Sustainable design principles are essential to creating sustainable urban environments. The literature study found that the use of sustainable design principles, such as energy efficiency, water management, waste management, and the use of environmentally friendly materials, is crucial to sustainable urban design in Indonesia. These principles can be integrated into the design process through interdisciplinary collaboration (Burmeister & van de Weg, 2018; Dias et al., 2014).

The study also identified the role of technology in sustainable urban design in Indonesia. Technology can be used to improve energy efficiency, water management, waste management, and transportation. For example, smart technology can be used to monitor energy use and improve energy efficiency in buildings. The use of renewable energy sources, such as solar panels, can also help to reduce energy consumption and greenhouse gas emissions. Additionally, technology can be used to improve water management through the use of rainwater harvesting and water-efficient irrigation systems. The use of technology can also help to improve waste management through the use of recycling and composting systems (Ahammed, 2017; Dameri & Rosenthal-Sabroux, 2014).

The literature study highlighted the importance of community participation in sustainable urban design. Community participation can help to ensure that the design of urban environments reflects the needs and preferences of the people living in the city. The involvement of the community can also help to ensure that sustainable design principles are integrated into the design process. Additionally, community participation can help to create a sense of ownership and pride in the urban environment (Abbott, 2013; Portschy, 2016).



### Challenges and Opportunities

The literature study identified several challenges and opportunities for interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology in sustainable urban design in Indonesia. One of the main challenges is the lack of coordination between the various disciplines involved. Interdisciplinary collaboration requires effective communication and coordination between the different disciplines, which can be challenging to achieve.

Another challenge is the lack of resources and funding for sustainable urban design projects. Sustainable design principles can be more expensive to implement than traditional design principles, which can be a barrier to their implementation. However, the study also identified several opportunities for interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology in sustainable urban design in Indonesia. One opportunity is the growing awareness of the importance of sustainable urban design among policymakers and the public. The Indonesian government has implemented policies to encourage sustainable urban design, which can create opportunities for interdisciplinary collaboration.

### Limitations

The literature study has several limitations. Firstly, the study only included research published in English language, which may have excluded relevant literature published in other languages. Secondly, the study was limited to research published between 2009 and 2023, which may have excluded earlier relevant literature. Finally, the study was limited to peer-reviewed journals, conference proceedings, and reports, which may have excluded relevant grey literature.

## 5. CONCLUSION

The interdisciplinary relations between architecture, urban planning, environmental engineering, and sociology play a crucial role in sustainable urban design in Indonesia. The literature study identified the importance of interdisciplinary collaboration, the need for sustainable design principles, the role of technology in sustainable urban design, and the importance of community participation. The study also identified challenges and opportunities for interdisciplinary relations between these disciplines in sustainable urban design in Indonesia. Future research should focus on developing effective models for interdisciplinary collaboration, identifying effective strategies for implementing sustainable design principles, and exploring the role of technology and community participation in sustainable urban design.

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