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Sustainability and Livability Characteristic in Urban Residential Areas: A Case Study of Petogogan Subdistrict, Jakarta, Indonesia.

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ABSTRACT: This study aims to evaluate the sustainability and livability levels of the Neighbourhood area at Jl. Wijaya I, Jakarta, using an integrative approach combining theories of sustainability, livability, regenerative, and neighbourhood. The research methodology involves the development of an indicator matrix based on theories and precedents, evaluation using a Likert scale, and analysis of area distribution patterns based on sustainability values. The results show that this area has high potential in supporting sustainable and livable living, with several analysis units recording good scores. Key factors determining the area's quality include the availability of green open spaces, circulation system efficiency, and the regulation of land-use intensity. Recommendations are provided to improve the area's quality, including increasing the proportion of green open spaces, optimizing pedestrian pathways, and controlling density.

Keywords:– Liveability, Neighbourhood, Regenerative, Sustainability

I. INTRODUCTION

In recent decades, the concepts of sustainability, livability, regenerative, and neighborhood have become central to urban planning and design. These concepts began to gain widespread recognition following the UN Agenda 21 at the Earth Summit in 1992, which highlighted the importance of sustainable development. In Indonesia, the implementation of these concepts has become increasingly relevant due to the challenges of rapid urbanization, as reported by Bappenas in the "National Sustainable Development Report" of 2021, emphasizing the need for a holistic approach to managing urban environments. These four concepts not only offer solutions to environmental issues but also provide a holistic approach that encompasses social, economic, and physical dimensions to create livable and sustainable environments.

This research area focuses on the Petogogan Subdistrict in South Jakarta, which is located between Jl. Wijaya I, Jl. Wolter Monginsidi, and Jl. Prof. Joko Sutono SH. This area is one of the urban regions with high density that faces urban environmental challenges. According to data from the Central Statistics Agency (2021), South Jakarta has a population density of 15,000 people per square kilometer, with a growth rate that continues to increase each year. This situation places significant pressure on green spaces, which only account for 10% of the total area, well below the minimum standard of 30% recommended by WHO for livable cities. Additionally, research by UN-Habitat (2014) highlights that challenges such as limited access to public transportation and environmental degradation complicate urban issues in this area.

Dense urban areas such as Jakarta face various urbanization problems, including limited green space, environmental degradation, and disparities in access to public facilities. Effective management of green open spaces can improve the quality of life for communities and support ecological sustainability[1]. Effective management of green open spaces can improve the quality of life for communities and support ecological sustainability [2]. In this context, the integration of the concepts of Sustainability, Livability, Regenerative, and Neighborhood becomes very important to create an environment that supports the quality of life for urban communities [3], [4], [5], [6].

The four concepts provide a comprehensive solution to these challenges by integrating physical element-based planning in urban areas. This focus on physical elements aims to create sustainable environments that enhance the quality of life for communities..

This study aims to identify and evaluate the integration of sustainability, livability, regenerative, and neighborhood indicators into urban area planning. The evaluation employs a Likert scale-based measurement tool designed to consider the relevance of physical and operational indicators. This matrix encompasses nine main design components, such as green open spaces, building layouts, and transportation systems, each weighted based on the number of specific indicators. The Likert scale design is based on methodological approaches widely used in urban studies to produce quantitative analyses that can be compared across sub-areas[3]. This goal is realized through the analysis of the implementation of the four concepts using a carefully designed measurement tool. The area evaluation tool, based on the Likert scale, is designed to provide quantitative results in measuring the success of these concepts' implementation. This approach enables a comprehensive analysis of sustainability, livability, and regeneration quality in an urban context while providing practical guidance for better area development.

This research offers a contribution by integrating four concepts—Sustainability, Livability, Regenerative, and Neighborhood—as a holistic approach that is rarely applied integratively in the urban context of Indonesia. These concepts aim to address major urban challenges such as environmental degradation, accessibility disparities, and limited green space, referencing evidence-based approaches from previous literature[7]. The integration of these concepts enables a more comprehensive analysis of urban areas, particularly in South Jakarta, which faces challenges like high population density, environmental degradation, and insufficient infrastructure.

1.1 Sustainability

The concept of Sustainability in urban architecture encompasses four main dimensions: environmental, social, economic, and design principles. The environmental dimension includes energy efficiency, carbon emission reduction, water management and resource recycling, as well as green spaces and vegetation. For instance, UN-Habitat highlights that efficient water management and green space provision can enhance the quality of life for urban communities [1]. Other research also adds that energy efficiency and urban vegetation play a critical role in mitigating the impacts of urbanization on the environment [8], [9]. Social Sustainability focuses on social inclusion, community interaction, cultural identity preservation, and societal well-being. Inclusive public spaces and designs that maintain local culture can foster social cohesion [10]. Community interaction spaces are also crucial for supporting sustainable development[2] Economic Sustainability emphasizes cost efficiency in construction, the use of recycled materials, energy-saving technologies, and long-term affordable housing as key components. Efficient material usage and renewable energy can reduce long-term operational costs[11], and the implementation of sustainability concepts also contributes to supporting local economies[3], [8], [11], [12]. Design Principles include design flexibility, the use of durable materials, the integration of public spaces, and aesthetics aligned with the environment. Flexible and adaptive design principles are important to meet future needs, while integrating public spaces supports sustainable social activities [3].

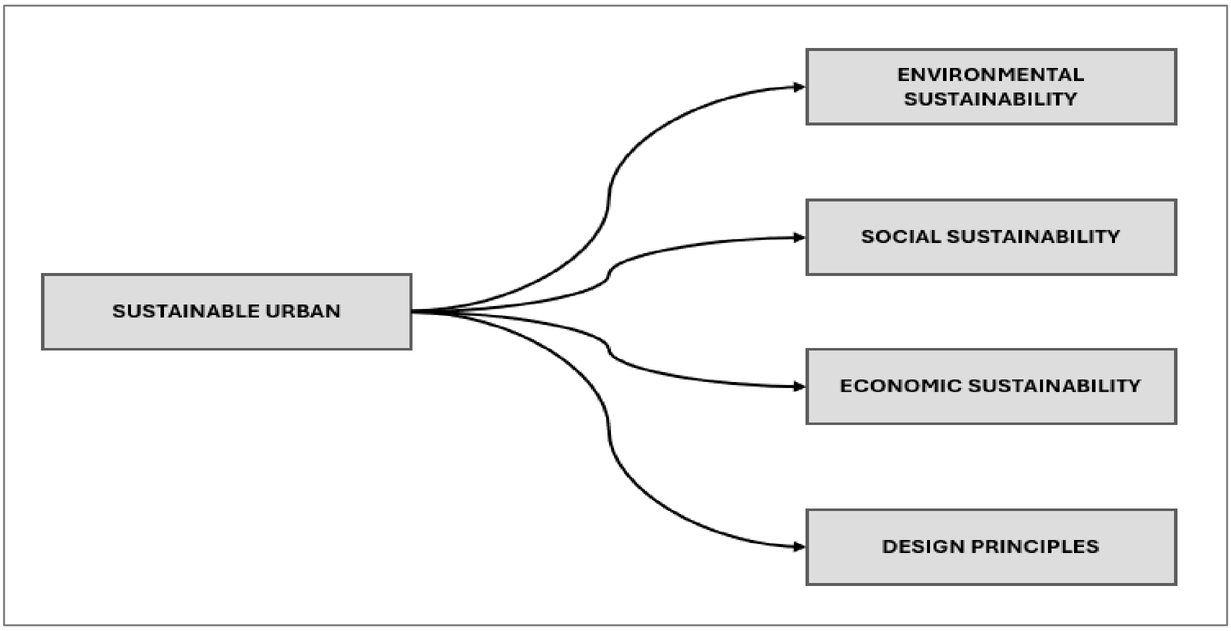

Figure 1- diagram of sustainable urban components

This diagram illustrates how each dimension contributes to the development of more sustainable urban areas, with each sub-component playing a crucial role in creating livable, inclusive, and environmentally friendly cities.

1.2 Regenerative Design

The Regenerative Design approach aims to create ecosystems that can renew themselves with human assistance. A notable example is the Bullitt Center in Seattle, USA, recognized as the world's greenest commercial building. This project utilizes 100% renewable energy, rainwater management systems, and sustainable building materials to generate a positive environmental impact [4], [8]. Additionally, this approach can be applied locally to support the regeneration of the built environment in urban areas through the integration of renewable energy and efficient recycling systems for materials [1], [10], [13].

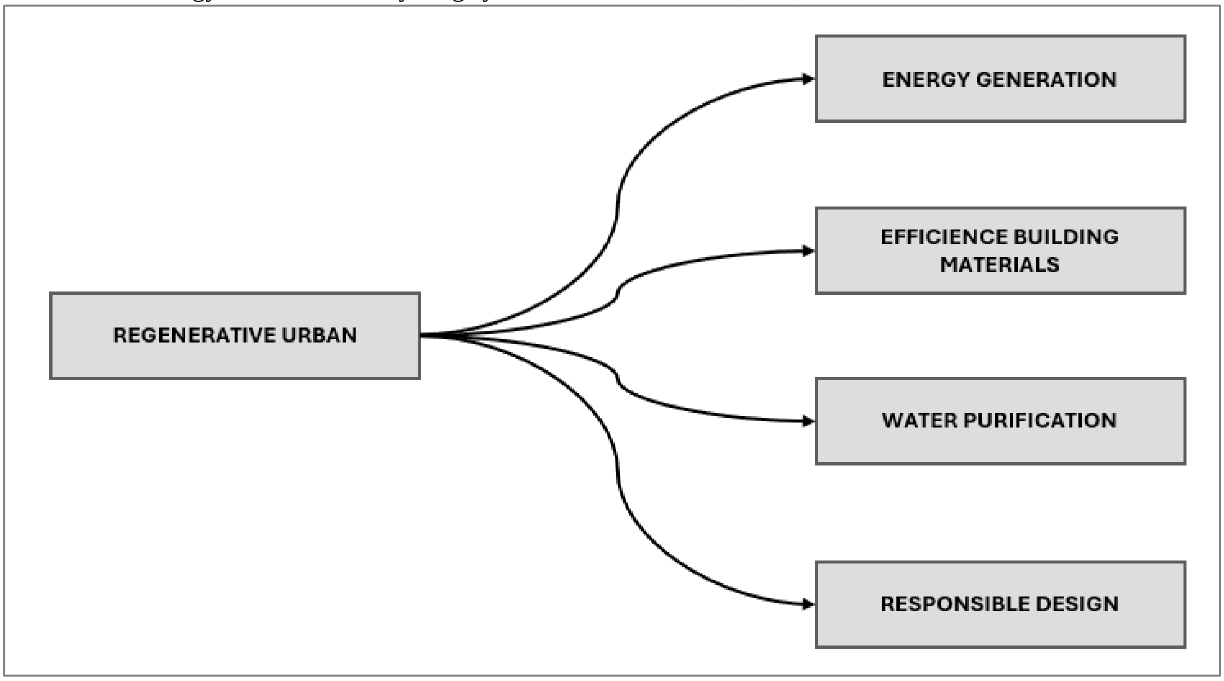

Figure 2 - diagram of regenerative urban components

Energy Generation involves the application of technologies such as Net Positive Energy Building, which generates more energy than it consumes. An example is the Bullitt Center in Seattle, which utilizes 100% renewable energy systems [4]. This system supports sustainability by reducing reliance on fossil fuels and enhancing energy efficiency in urban buildings [8]. Material Effectiveness focuses on the use of local and recycled materials to minimize environmental impact. Waste material management is a priority in supporting ecosystem regeneration. Environmentally friendly materials not only reduce carbon emissions but also support the sustainable life cycle of buildings[10] Purifikasi Air (Water Purification) mencakup integrasi teknologi purifikasi air untuk mengurangi limbah dan memanfaatkan kembali air limbah dalam sistem bangunan. Pengelolaan air yang efektif dapat mendukung regenerasi lingkungan, terutama di kawasan urban dengan keterbatasan sumber daya air bersih Water Purification includes the integration of water purification technologies to reduce waste and reuse wastewater in building systems. Effective water management can support ecosystem regeneration, especially in urban areas with limited water resources[2], [10], [13] . Responsible Place ensures that buildings are designed with consideration for the local ecosystem and social needs. Design flexibility and public space integration are considered essential to create adaptive environments that promote social cohesion [2].

With these four components, regenerative architecture contributes to the development of urban areas that support ecosystem regeneration, maximize energy efficiency, and create environments that are community-friendly. A notable success is the Bullitt Center in Seattle, USA, recognized as the world's greenest commercial building. This project utilizes 100% renewable energy, rainwater management systems, and sustainable building materials to generate a positive environmental impact [4], [8]. Additionally, this approach can be applied locally to support the regeneration of built environments in urban areas through the integration of renewable energy and efficient recycling systems for materials [1], [10].

1.3 Livability

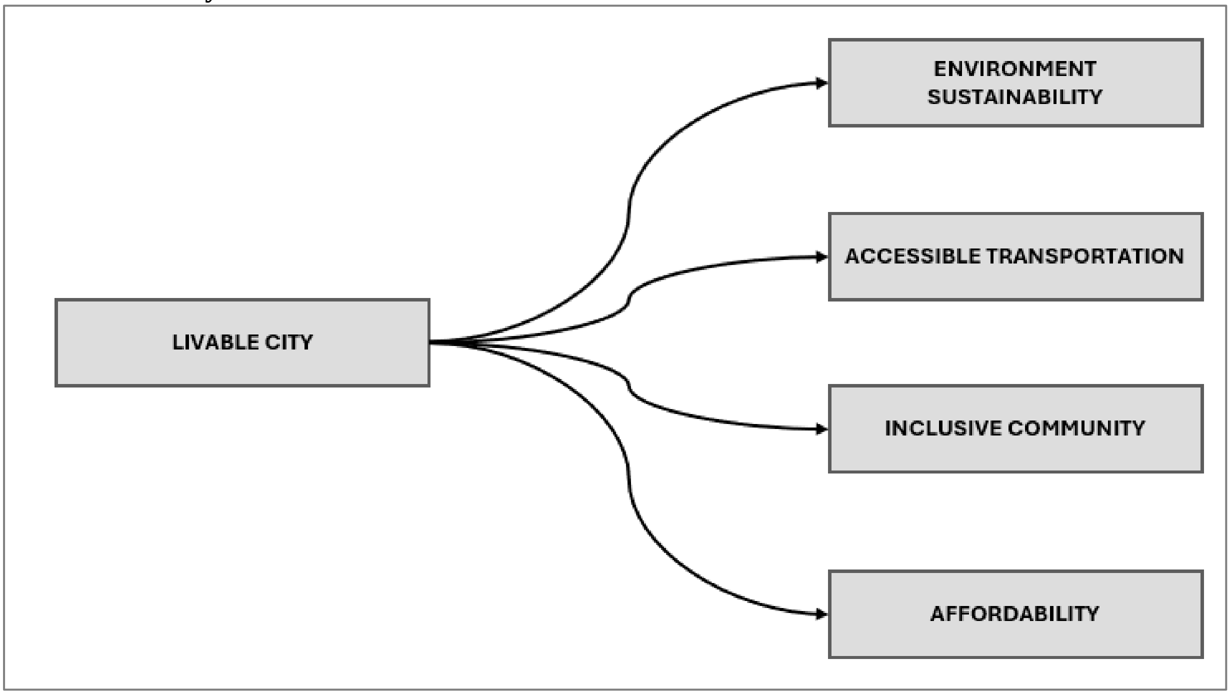

Figure 3 - diagram of livable city components

Livability refers to the quality of life experienced by residents, reflecting how comfortable, safe, and healthy the environment is for its inhabitants. This concept encompasses several essential aspects. First, Environmental Sustainability focuses on energy efficiency, carbon emission reduction, the provision of green spaces and vegetation, as well as water management and resource recycling. Adequate green space management can enhance the quality of life for urban communities while mitigating the impacts of climate change. Energy efficiency and carbon emission reduction are key components in building environmentally friendly cities [1], [8]. Second, Accessible Transportation, which is efficient, environmentally friendly, and easy to access, becomes a critical element in creating livable cities. Public transportation accessibility not only supports community mobility but also reduces dependency on private vehicles, contributing to lower carbon emissions. This has a direct positive impact on the quality of life of urban residents [14]. Third, Inclusive Community, involving social interaction, equal access to facilities, and respect for cultural diversity. Cultural diversity in urban communities must be supported by inclusive public space designs to promote social cohesion. This includes spaces that encourage individual interaction while maintaining the local cultural identity [15]. Fourth, the Affordability Aspect, which ensures that basic facilities such as housing, transportation, and public services are accessible to various societal layers. Urban sustainability also depends on the affordability of facilities, ensuring they not only meet the needs of the upper class but also provide equal access for vulnerable groups[8].
These four aspects work synergistically to create sustainable, inclusive, and livable cities that support the quality of life for residents. By integrating environmental sustainability, accessible transportation, inclusive communities, and affordability, cities can become more comfortable places to live while promoting ecological sustainability and social well-being.

1.4 Neighborhood

Neighborhood, as a fundamental unit of urban planning, encompasses various elements that holistically support community life. These elements include housing integrated with public facilities such as schools, parks, and healthcare centers, which facilitate social interaction among residents [16].]. Open space planning is also a key factor, creating green spaces that promote physical and mental health [17]. Additionally, physical components such as pedestrian paths and strategically designed bike lanes enhance community accessibility and mobility while supporting environmental sustainability [18]. In modern urban planning, neighborhoods serve as connectors between the micro-scale (housing) and macro-scale (the city as a whole), ensuring a balance between individual and community needs.

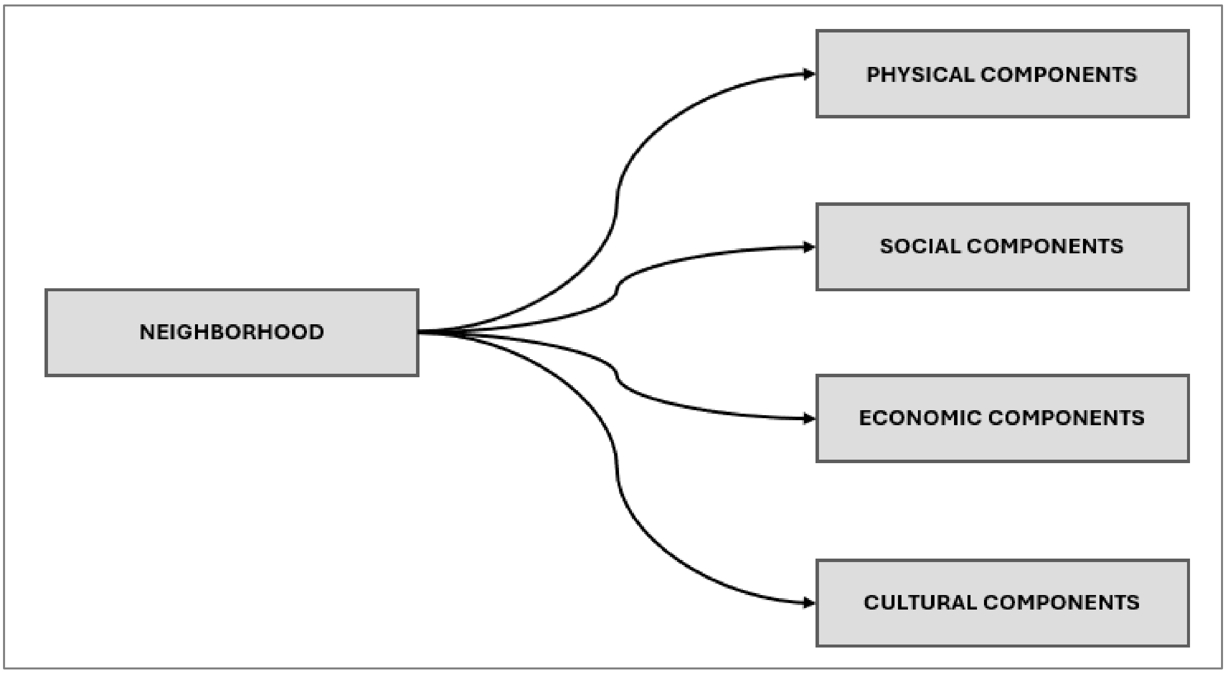

Figure 4 - diagram of neighborhood components

The diagram above illustrates the structure of key elements supporting sustainable urban environment development. These components are divided into four main categories: Physical Components, Social Components, Economic Components, and Cultural Components. Physical Components include the provision of green open spaces that support public health and mitigate the impacts of climate change. UN-Habitat (2014) highlights that green spaces act as the lungs of a city, not only supporting ecosystems but also providing psychological benefits for urban residents [1]. Additionally, Spatial Form and Layout involve the arrangement of road patterns and building typologies to enhance space efficiency and accessibility. Well-organized spatial layouts help create user-friendly environments and facilitate better spatial orientation [17]. Social Components include diverse age structures, education levels, and incomes, which are essential for creating inclusive communities. Diversity within communities should be supported by public spaces that facilitate social interactions to strengthen social cohesion[15]. Social Interaction is also a critical element in building relationships among individuals in urban environments. Inclusive public space designs can support social interaction and enhance a sense of belonging to the environment [10]. Economic Components encompass support for micro and macro businesses that serve as the main pillars of the urban economy. The integration of economic activities into neighborhood planning can encourage inclusive economic growth [11]. Efficient public transportation accessibility is also key to supporting economic activity and community mobility. Good accessibility can reduce economic disparities and improve quality of life[14]. Cultural Components refer to preserving local culture as the identity of an area. A good neighborhood should reflect local cultural identity to create a sense of connection for its residents [6]. Identity means maintaining local uniqueness through architecture and spatial planning that reflect the character of the local culture. Cultural aesthetics in public space design strengthen community pride in their environment [10]

1.5 Integration of concepts

These four concepts can complement each other in creating sustainable, livable, regenerative, and inclusive urban areas. One example of such integrated implementation can be seen in Hammarby Sjöstad in Stockholm, Sweden. This neighborhood adopts a holistic approach by combining sustainable design, efficient water and energy management systems, and spatial planning that supports non-motorized mobility. Through the integration of renewable energy systems and waste management, the neighborhood successfully creates an urban environment that enhances the quality of life for its residents while preserving the local ecosystem. Furthermore, it is important to emphasize evidence-based planning that includes operational sustainability indicators, such as the use of environmentally friendly materials and transportation efficiency. This integration aims not only to improve the quality of life for communities but also to ensure that urban development aligns with long-term environmental preservation.[3], [11].

2. Methods of Research

This research adopts a quantitative approach with a descriptive analysis to evaluate the sustainability, livability, regenerative, and neighborhood aspects of the study area. The method involves the systematic collection and analysis of data using a structured framework that integrates key indicators from relevant theories, regulations, and precedents. The research methodology is divided into several stages, beginning with the development of an evaluation matrix, which consolidates various design components into measurable indicators. These indicators are categorized based on their relevance to the four core concepts—Sustainability, Livability, Regenerative, and Neighborhood ensuring a comprehensive evaluation framework. The data collection process involves both primary and secondary sources. Primary data is obtained through surveys and direct observations of the study area, while secondary data is sourced from existing literature, government regulations, and case studies of similar urban settings. The assessment is carried out by evaluating the physical, social, economic, and environmental aspects of the study area, ensuring an integrated approach that provides practical insights for future urban development strategies.The collected data is then analyzed to identify key strengths and weaknesses, which will form the basis for strategic recommendations aimed at improving the study area's sustainability and livability.

2.1 Concept Matrix Development

The research framework for this study is developed based on the integration of four key urban planning concepts: Sustainability, Livability, Regenerative Design, and Neighborhood. These concepts form the foundation for evaluating the physical, social, economic, and environmental aspects of the study area. The framework is structured to ensure a comprehensive understanding of how these elements interact to create an urban environment that is both functional and resilient.

Table 1 - Hamid Shirvani's Design Components

No	Design Concept	Definition
1	Land Allocation Structure	Determines the zoning and distribution of land use functions such as residential, commercial, and public spaces to ensure land efficiency and optimal utilization.
2	Land Use Intensity	Regulates density through indicators such as Floor Area Ratio (FAR) and Building Coverage Ratio (BCR) to prevent overcrowding.
3	Building Layout	Ensures building orientation to optimize airflow, natural lighting, and connectivity between different parts of the area.
4	Circulation System and Connecting Pathways	Focuses on planning networks of roads, pedestrian paths, and bike lanes that integrate with mass mobility systems. This system aims to improve accessibility and connectivity while prioritizing non-motorized transportation. Roads and pathways are designed strategically to enhance comfort, safety, and efficiency in the use of public facilities while fostering social interaction within the community.
5	Open Space and Green Space	Consists of elements that ensure the comfort, health, and sustainability of the urban environment. It considers air quality, natural lighting, noise control, and air pollution management. Additionally, landscape features that support a pedestrian-friendly environment play a vital role in improving public health and creating productive and attractive spaces.
6	Environmental Quality Management	Focuses on infrastructure management to support sustainable urban life. Clean water distribution, rainwater management, and waste management systems aim to minimize environmental impacts. Sustainable energy sources such as solar panels and wind turbines are encouraged, while solid waste management systems enhance resource efficiency.
7	Infrastructure-Utilities	Covers essential infrastructure that supports urban life, including clean water distribution, waste management, and energy infrastructure such as electricity and renewable energy sources. Transportation infrastructure, including pedestrian and bicycle pathways, is also considered vital for mobility and sustainability.
8	Actvity Support	Refers to facilities and infrastructure that accommodate various social and economic activities. Public spaces such as parks, plazas, and sports facilities support community engagement, while commercial areas foster economic vitality and social interaction.
9	Conservation/Preservation	Involves efforts to preserve cultural heritage and ecological balance by maintaining environmental quality and enhancing the resilience of urban areas to climate change.

Each design component is mapped to specific indicators from literature, regulations, and precedents to ensure that the resulting measurement tools can be practically applied in urban areas of South Jakarta.

2.2 Determination of Measurement Indicators

The research indicators are derived from three main sources: literature review, regulations, and precedents. The literature review involves referring to scientific journals that discuss the physical elements of urban areas and sustainability, such as green spatial planning, energy efficiency, and mobility. Regulations include official documents such as the Jakarta Spatial Plan (RTRW) and the Spatial Planning Law to ensure compliance with local policies. Additionally, precedents are drawn from case studies of international regenerative projects such as Hammarby Sjöstad in Sweden and the Bullitt Center in Seattle, which serve as successful examples of concept implementation. In compiling the matrix for each concept—Sustainability, Regenerative, Livability, and Neighborhood—this study refers to various relevant and operational literature, regulations, and precedents. Each matrix is designed to include indicators that focus on the physical elements of the area. The process involves identifying sustainability indicators through scientific journals discussing energy efficiency, resource management, and green spaces, with local regulations such as RTRW and the Medium-Term Development Plan (RPJM) serving as primary references to ensure relevance to the Indonesian context. Regenerative aspects are developed based on case studies of international projects and regulations related to waste management and renewable energy. Indicators supporting livability focus on transportation accessibility, public spaces, and social facilities, referring to relevant literature and government policies. Lastly, the neighborhood matrix includes physical elements that strengthen social cohesion, such as spatial design, public facilities, and pedestrian pathways, with data obtained from journals, zoning regulations, and successful precedents.

After compiling each matrix, the indicators are combined into a single comprehensive matrix that incorporates all concepts and complementary indicators, creating a thorough and operational measurement tool. This combined matrix is expected to provide a comprehensive evaluation guide for urban areas in South Jakarta.

Table 2- Sustainability Concepts' Physical Indicators

Design Component	Sustainability Concept	Source of References
Land Allocation Structure	1. The distance between land-use functions is 500 to 800 meters. 2. Mixed-use areas should make up 20% of the total area. 3. 30% of the area must be allocated for Green Open Spaces (RTH). 4. Building density should be in accordance with the Basic Building Coefficient (KDB).	*Humaira, R. F., Handoko, T. W., & Akilah, M. A. (2024). Penerapan konsep Transit-Oriented Development dalam jalur pedestrian Margonda Raya, Depok.* *Nazwar, H. A. (2021). Transit Oriented Development: Insentif Terhadap Nilai Properti. Jurnal Manajemen Aset dan Penilaian, 1(2), 30-39* *UU No. 26 Tahun 2007 tentang Penataan Ruang* *RDTR Jakarta dan Rencana Tata Ruang Wilayah Jakarta 2024-2044*
Land Use Intensity	1. Road ratio 10%-25% of the total area in the zone.	*Litman, T. (2016). Determining optimal urban expansion, population and vehicle density, and housing types. Proceedings of the World Conference on Transport.*
Building Layout		
Circulation System and Connecting Pathways	1. Provide pedestrian pathways within the area. 2. Pedestrian pathways equipped with shade covering at least 60% of the total length of the pedestrian pathways. 3. The area has access to mass public transportation within a radius of 400 meters from the outermost side of the area. 4. Minimum width of 1.5 meters for pedestrian pathways on local roads in residential areas.	*SNI 03-2443-1991* *Green Building Council Indonesia*
Open Space and Green Space	1. Public open space (RTH) minimum 20% 2. Private open space (RTH) minimum 10% 3. Residential green area 60% 4. Mixed-use green area 40% 5. Commercial green area 30%	*Peraturan Menteri ATR/BPN Nomor 14 Tahun 2022 tentang Penyediaan dan Pemanfaatan RTH* *The Berlin Biotope/Green Area Factor Project*
Environmental Quality Management	-	
Infrastructure-Utilities	1. The presence of natural infiltration areas in the area. 2. There are at least 6 (six) types of facilities within a reach of 400 meters (Road Network, Environmental Drainage, Clean Water Supply System, Wastewater Management, Waste Management, Public Street Lighting, Green Open Space (RTH)).	*Green Building Council Indonesia* *The Staten Island Bluebelt Project*
Actvity Support	1. Providing facilities where the community can interact and engage in activities, with a minimum radius of 400 meters.	*Green Building Council Indonesia*
Conservation/Preservation	1. Maintain at least 20% of the existing mature large trees in the area.	*Green Building Council Indonesia*

Table 3-Regenerative Concepts' Physical Indicators

Design Component	Regenerative Concept	Source of References
Land Allocation Structure	1. 30% of the total area is allocated for green space and natural vegetation. 2. 20% for public facilities that support community sustainability.	*Hammarby Sjöstad, Swedia. Case Study* *Mang & Reed, "Regenerative Development and Design," 2016*
Land Use Intensity	1. A maximum of 50%-60% of the total land area is allocated for buildings.	
Building Layout	1. Modular and Adaptable Shapes with a percentage of 20%-30% of the building's form designed to be modular and adaptive to accommodate future functional changes.	*Local Regulation*
Circulation System and Connecting Pathways	1. Public Transportation Circulation System: 70% of transportation is based on low-emission or electric-powered public vehicles. 2. Private Vehicle Circulation System: 40% of parking areas integrated with vertical vegetation to reduce heat. 3. Parking System: 30% of parking uses permeable paving. Bicycle and pedestrian paths occupy 40% of road space.	*Cervero, R. "Transport Sustainability and Urban Regeneration," 2018* *Peraturan Menteri Perhubungan No. 11 Tahun 2017 tentang Pedoman Transportasi Berkelanjutan.* *Newman & Kenworthy, "Cities and Sustainable Development," 2015*
Open Space and Green Space	1. Public Open Space: 50% of public spaces are based on natural vegetation. 2. Private Open Space: 25% of the total building area is allocated for private gardens equipped with local vegetation. 3. Tree Planting and Green Planning System: 30% of trees in residential areas must be native local species. 4. Landscape: 20% of the total project area is dedicated to the restoration of natural habitats.	*UN Environment Programme, 2021; IPCC Report on Urban Green Infrastructure, 2020* *Sesuai UU No. 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup*
Environmental Quality Management	1. Environmental Identity: 60% of environmental design elements reflect local character. 2. Environmental Orientation: 70% of buildings optimize orientation for access to natural light and cross ventilation to reduce the need for artificial energy. 3. Streetscape: 50% of street areas are optimized with vegetation to enhance aesthetics and reduce the heat island effect.	*Passive Design Principles for Regenerative Architecture," Renewable Energy Journal, 2018* *Permen PUPR No. 2 Tahun 2015 tentang Bangunan Gedung Hijau*
Infrastructure-Utilities	1. Clean Water Network: 80% of clean water is obtained through rainwater recycling systems and natural purification technologies. 2. Electricity Network: 50% of energy is sourced from renewable sources, such as solar panels or wind turbines. 3. Drainage Network: 60% of rainwater is captured and absorbed through porous drainage systems and bioswales.	*Water Sensitive Urban Design," Journal of Hydrology, 2019* *Undang-Undang No. 30 Tahun 2007 tentang Energi.*
Actvity Support	1. Transit Areas: 70% of transit areas provide environmentally friendly facilities. 2. 50% of transit areas are designed for public transportation integration. 3. 60% of connecting routes are equipped with green vegetation. 4. 80% of connecting routes are designed for universal accessibility.	*UU No. 22 Tahun 2009 tentang Lalu Lintas dan Angkutan Jalan* *Transit-Oriented Development (TOD) for Sustainable Cities," Journal of Urban Planning, 2020* *Peraturan Menteri Perhubungan No. PM 52 Tahun 2018*
Conservation/Preservation	1. Percentage of land that has been rehabilitated: 70%-100% of the area that was previously damaged due to human activities.	*Hammarby Sjöstad, Swedia. Case Study*

		Mang & Reed, "Regenerative Development and Design," 2016

Table 4-Livability Concepts' Physical Indicators

Design Component	Livability Concept	Source of References
Land Allocation Structure	1. Planning should include providing Green Open Spaces (RTH) of at least 30% of the total area.	*A Livable City: Rational Land Use and Sustainable Urban Space* *New Approaches to Housing Complexity: Designing for Livable Cities* ***RTRW berdasarkan UU No. 26 Tahun 2007***
Land Use Intensity		
Building Layout	Floor Area Ratio is determined based on zone classification.	*Peraturan Pemerintah RI No. 36 Tahun 2005 tentang Peraturan Pelaksanaan UU No. 28 Tahun 2002 tentang Bangunan Gedung*
Circulation System and Connecting Pathways	1. Provision of connected sidewalks that are safe from vehicles. 2. Integration of public transportation (buses, trains, MRT, LRT) with private transportation systems. 3. Provision of separate bicycle lanes from the main roads for the safety of users, with integration of bicycle lanes with public facilities and residential areas.	*Permen **PUPR No. 03/PRT/M/2014*** ***UU No. 28 Tahun 2002***
Open Space and Green Space	1. Green Open Space (RTH) must cover at least 30% of the total area: 20% public RTH, 10% private RTH.	***Permen PUPR No. 1 Tahun 2022*** ***UU No. 26 Tahun 2007***
Environmental Quality Management	1. Provision of domestic wastewater treatment infrastructure. 2. Provision of organic waste treatment infrastructure. 3. Adding noise barriers such as green walls or sound insulation materials.	***PP No.82 Tahun 2001*** *Planning Energy Efficient and Livable Cities.* ***UU No. 18 Tahun 2008***
Infrastructure-Utilities	1. Provision of energy-efficient and environmentally friendly public street lighting. 2. Standards for pedestrian pathways: (Primary Walkways: Minimum width of 3 meters), (Secondary Walkways: Minimum width of 1.5 meters), (Accessibility for Persons with Disabilities: Minimum width of 1.5 meters).	*Planning Energy Efficient and Livable Cities.* ***Permen PUPR) No. 03/PRT/M/2014*** ***Permen PUPR No. 16 Tahun 2016 tentang Penerangan Jalan Umum**:*
Actvity Support	1. Availability of various facilities with good accessibility that support inclusivity. 2. Maximum distance to public facilities (schools, markets, hospitals) should not exceed 500 meters from residential areas.	*Safdari Molan, A., et al. (2019). Providing a Livable Housing Development Model*
Conservation/Preservation		

Table 5- Neighborhood Concepts' Physical Indicators

Design Component	Neighborhood Concept	Source of References
Land Allocation Structure	1. Open Spaces: Around 10-30% of the total land should be allocated for parks or community-supporting spaces. 2. Green space ratio: There should be access to public green spaces within 500 meters.	***Maas, J., et al. (2006)**. Green Space, Urbanity, and Health.* ***Benedict, M.A., & McMahon, E.T. (2002)**. Green Infrastructure: Smart Conservation for the 21st Century.*

Design Component	Neighborhood Concept	Source of References
		Permen ATR/BPN No. 16/2018
Land Use Intensity	1. Housing density ratio: 40-100 units per hectare.	***Jackson, L.E. (2003)****. The Relationship of Urban Design to Human Health and Condition.*
Building Layout	1. Distance between buildings: 3-10 meters. 2. Floor Area Ratio (FAR): 1.5-3.0 for mixed-use areas. 3. Building height proportion: Maximum of 2-3 floors in residential areas, adjusted to the surrounding environment.	***Handy, S.L., & Ewing, R. (2002)****. How the Built Environment Affects Physical Activity.* ***Ewing, R., & Handy, S. (2009)****. Measuring the Unmeasurable: Urban Design Qualities Related to Walkability*
Circulation System and Connecting Pathways	1. Road network ratio: 30%-40% of the total area.	***Permen PUPR No. 3/2021***
Open Space and Green Space	1. Green space proportion: 10%-30% of the total area. 2. Minimum green space size: ≥ 2 hectares.	***Grahn, P., & Stigsdotter, U.A. (2003)****. Landscape Planning and Stress* ***Van Herzele, A., & Wiedemann, T. (2003)****. A Monitoring Tool for Accessible and Attractive Urban Green Spaces.*
Environmental Quality Management		
Infrastructure-Utilities	1. Distance to public facilities: ≤ 500 meters. 2. Intersection density: (1/11,000) intersections/km². 3. Ratio of sidewalk length to total road length: Minimum 50%. 4. Road network width: 6 meters.	***Zuniga-Teran, A.A., et al. (2017)****. Neighborhood Design, Physical Activity, and Wellbeing.* ***Badland, H., et al. (2013)****. Using Simple Agent-Based Modeling to Inform and Enhance Neighborhood Walkability.* ***Talen, E., & Koschinsky, J. (2013)****. The Walkable Neighborhood: A Literature Review.*
Actvity Support	1. Distance to public transportation: ≤ 400-500 meters. 2. Availability of pedestrian and bicycle facilities: ≥ 70% of the main roads. 3. Sidewalk width: Minimum **1.8 meters** for pedestrian paths. 4. Ratio of bus stops/stations per km²: Minimum 5 stops/km².	***Permen PUPR No. 3/2021*** ***Asadi-Shekari, Z., et al. (2015).*** *Pedestrian safety index for evaluating street facilities in urban areas.*
Conservation/Preservation	1. ≥ 50% of materials should be reused during renovation.	***Cloutier, S., et al. (2018).*** *Toward a Holistic Sustainable and Happy Neighborhood Development Assessment Tool*

Then, all measurement indicators for each concept were thoroughly evaluated with practical considerations to ensure their relevance to the context of the area. A reference evaluation was also conducted to verify the validity and reliability of the selected references. After completing these two stages, the final measurement tool was determined, which will subsequently be used as an evaluation tool. The following table presents the final results of the measurement indicators:

Table 6-Physical Indicators / Measurement Tools

Design Component	Physical Indicators/Measurement Tool
Land Allocation Structure	1. Distance between land use functions: 500-800 meters. 2. Mixed-use area: 20% of the total area. 3. 30% of the area allocated for Green Open Space (RTH). 4. Building density in accordance with BCR (Building Coverage Ratio). 5. 20% allocated for public facilities that support community

Design Component	Physical Indicators/Measurement Tool
	sustainability. 6. Green space ratio: Public green space access must be available within every 500 meters.
Land Use Intensity	1. Road ratio: 10%-25% of the total land area in the region. 2. Maximum BCR (Building Coverage Ratio) for residential areas: 60%. 3. Maximum BCR (Building Coverage Ratio) for commercial areas: 80%.
Building Layout	1. At least 20% of building forms must be designed using modular construction. 2. FAR (Floor Area Ratio) must comply with zoning classification. 3. Distance between buildings: Minimum 3 meters, maximum 10 meters. 4. Maximum residential building height: 3 floors.
Circulation System and Connecting Pathways	1. Pedestrian pathways must have a minimum of 60% shading along their entire length. 2. The area must have access to mass public transportation within a 400-meter radius from the outermost boundary. 3. Minimum sidewalk width: 1.5 meters for pedestrian pathways on local roads in residential areas. 4. Minimum sidewalk width: 3 meters for pedestrian pathways on local roads in primary road areas. 4. Public Vehicle Circulation System: 70% of transportation should be based on low-emission or electric public vehicles. 5. Bicycle and pedestrian lanes should account for 40% of the total road width. 6. Pedestrian pathways must be 100% interconnected. 7. Bicycle lanes should be separated from motor vehicle lanes.
Open Space and Green Space	1. Minimum public green open space (RTH): 20%. 2. Minimum private green open space (RTH): 10%. 3. Commercial green area: 30%. 4. At least 30% of trees in residential areas must be native species.
Environmental Quality Management	1. Streetscape: 50% of the road area should be optimized with vegetation to enhance aesthetics and reduce the urban heat island effect. 2. Availability of organic waste management infrastructure. 3. Presence of noise barriers in the form of green walls or secondary skin.
Infrastructure-Utilities	1. Presence of natural infiltration areas within the region. 2. Availability of at least six types of facilities within a 400-meter radius, including Road Network, Environmental Drainage, Clean Water Supply System, Wastewater Management, Waste Management, Public Street Lighting, and Green Open Space (RTH). 3. Availability of alternative energy sources from renewable resources, such as solar panels or wind turbines. 4. Provision of energy-efficient and environmentally friendly public street lighting. 5. Minimum width of accessible pathways for disabled persons: 1.5 meters. 6. Distance to public facilities should be equal to or less than 500 meters. 7. Minimum local road width: 6 meters.
Actvity Support	1. 80% of connecting pathways are designed for universal accessibility. 2. Ratio of bus stops/stations: 5 points per km².
Conservation/Preservation	1. Maintain at least 20% of mature trees existing within the area

2.3 Likert Scale and Indicator Weighting

Each of the nine design components has a different number of indicators or measurement tools, which affect the weighting of each measurement tool. The weight of each design component is calculated using the formula: the total number of measurement tools in each component divided by the total number of measurement tools, which is 37. This calculation ensures that each component receives a proportional weight according to its contribution to the overall evaluation. These weights are then integrated into the evaluation system, allowing for comparisons between sub-areas and supporting quantitative analysis to identify priority areas for improvement. Each indicator in the research measurement tool will be assigned a Likert scale ranging from 1 (very poor) to 5 (very good). The point distribution is as follows:

Table 7 - Likert Scoring Scale

0,0-1,0	Very Poor
1,1-2,0	Poor
2,1-3,0	Fair
3,1-4,0	Good
4,1-5,0	Very Good

Table 8 - Likert Scale Concept for each Measurmenet Tool

Komponen Rancangan	**Bobot**	**Indikator / Tolak Ukur**		**Skala Likert**				
Land Allocation Structure	0,16	1	Distance between land use functions: 500-800 meters.	1	2	3	4	5
				≥800m		650m		≤500m
		2	Area mix use 20% of the total area.	1	2	3	4	5
				0%				≥20%
		3	30% of the area designated for Green Open Space	1	2	3	4	5
				0%				≥30%
		4	Building density in accordance with local BCR (Building Coverage Ratio)	1	2	3	4	5
				Not complied		50% Complied		Complied
		5	Building density in accordance with BCR (Building Coverage Ratio).	1	2	3	4	5
				0%				≥20%
		6	Green space ratio: Public green space access must be available within every 500 meters.	1	2	3	4	5
				≥501m				≤500m
Land Use Intensity	0,08	1	Road ratio: 10%-25% of the total land area in the region.	1	2	3	4	5
				≤10%		17,50%		25%
		2	Maximum BCR (Building Coverage Ratio) for residential areas: 60%.	1	2	3	4	5
				>100 unit				<40 unit
		3	Maximum BCR (Building Coverage Ratio) for commercial areas: 80%.	1	2	3	4	5
				0%				100%
Building Layout	0,11	4	At least 20% of building forms	1	2	3	4	5
				0%		10%		≥20%

			must be designed using modular construction.					
		5	FAR (Floor Area Ratio) must comply with zoning classification.	1	2	3	4	5
				Not complie d		50% Complie d		Complied
		6	Distance between buildings: Minimum 3 meters, maximum 10 meters.	1	2	3	4	5
				≤3m		6,5m		10m
		7	Maximum residential building height: 3 floors.	1	2	3	4	5
				>3lapis				≤3lapis
Circulation System and Connecting Pathways	0,19	1	Pedestrian pathways must have a minimum of 60% shading along their entire length.	1	2	3	4	5
				0%	15%	30%	45%	≥60%
		2	The area must have access to mass public transportation within a 400-meter radius from the outermost boundary.	1	2	3	4	5
				>401m				≤400m
		3	Minimum sidewalk width: 3 meters for pedestrian pathways on local roads in primary road areas.	1	2	3	4	5
				0m		1,5m		≥3m
		4	Minimum sidewalk width: 1.5 meters for pedestrian pathways on local roads in residential areas.	1	2	3	4	5
				0m		0,75m		≥1,5m
		5	Bicycle and pedestrian lanes should account for 40% of the total road width	1	2	3	4	5
				0%		20%		40%
		6	Pedestrian pathways must be 100% interconnected	1	2	3	4	5
				0%	25%	50%	75%	100%
		7	Bicycle lanes should be separated from	1	2	3	4	5
				Separate d		Partially -		Separated

			motor vehicle lanes			separated		
Open Space and Green Space	0,11	1	Minimum public green open space (RTH): 20%.	1	2	3	4	5
				0%		10%		≥20%
		2	Minimum private green open space (RTH): 10%.	1	2	3	4	5
				0%		5%		≥10%
		3	Commercial green area: 30%.	1	2	3	4	5
				0%		15%		≥30%
		4	At least 30% of trees in residential areas must be native species.	1	2	3	4	5
				0%		15%		≥30%
Environmental Quality Management	0,08	1	Streetscape: 50% of the road area should be optimized with vegetation to enhance aesthetics and reduce the urban heat island effect.	1	2	3	4	5
				0%		25%		50%
		2	Availability of organic waste management infrastructure.	1	2	3	4	5
				Not available	-	-	-	Available
		3	Presence of noise barriers in the form of green walls or secondary skin.	1	2	3	4	5
				Not available	-	-	-	Available
Infrastructure-Utilities	0,19	1	Presence of natural infiltration areas within the region	1	2	3	4	5
				Not available	-	-	-	Available
		2	Availability of at least six types of facilities within a 400-meter radius, including Road Network, Environmental Drainage, Clean Water Supply System, Wastewater Management, Waste Management, Public Street Lighting, and Green Open Space (RTH).	1	2	3	4	5
				0 Facility	1 Facilities	2-3 Facilities	4-5 Facilities	6 Facilities
		3	Availability of alternative energy sources from renewable	1	2	3	4	5
				Not available	-	-	-	Available

			resources, such as solar panels or wind turbines.					
		4	Provision of energy-efficient and environmentally friendly public street lighting.	1	2	3	4	5
				Not availabl e	-	-	-	Not available
		5	Minimum width of accessible pathways for disabled persons: 1.5 meters.	1	2	3	4	5
				0m	-	0,75m	-	≥1,5m
		6	Distance to public facilities should be equal to or less than 500 meters.	1	2	3	4	5
				≥501m	-	-	-	≤500m
		7	Minimum local road width: 6 meters.	1	2	3	4	5
				0m	-	3m	-	≥6m
Activity Support	0,05	1	80% of connecting pathways are designed for universal accessibility.	1	2	3	4	5
				0%		40%		≥80%
		2	Ratio of bus stops/stations: 5 points per km².	1	2	3	4	5
				1 point		3 points		≥5 points
Conservation / Preservation	0,03	1	Maintain at least 20% of mature trees existing within the area	1	2	3	4	5
				0%		10%		≥20%
Total Bobot	1,00							

III. RESULTS AND DISCUSSION

This section presents the findings of the study based on the evaluation of the designated urban area, focusing on the key components of sustainability, livability, regenerative design, and neighborhood development. The analysis was conducted using a structured evaluation matrix that incorporates physical indicators from literature, regulations, and case studies. The results provide insights into the performance of each sub-area, highlighting strengths and areas that require improvement. The discussion aims to interpret these findings in relation to the overall objectives of sustainable urban development, emphasizing the importance of green spaces, transportation infrastructure, and public facilities in creating a balanced and resilient urban environment. The following subsections detail the characteristics of the analysis units and the key factors influencing their evaluation scores.

2.4 Evaluation Area

The evaluation area is located in Petogogan Subdistrict, South Jakarta, bordered by Jl. Wijaya I, Jl. Wolter Monginsidi, and Jl. Prof. Joko Sutono SH. The area is divided into 30 sub-areas as analysis units, each with varying sizes and physical characteristics. This division is based on spatial patterns and land use identified through Google Earth imagery, field observations, and the zoning map of the South Jakarta Spatial Plan (RTRW).

Figure 5-Satelite Image of Evaluated Neighborhood Area

Each sub-area is analyzed using the measurement tools compiled in the integrated matrix. The assessment is conducted based on indicators covering nine design components, such as green open spaces, circulation systems, and land use intensity. The following table summarizes the basic characteristics of the analyzed sub-areas:

Unit Analisis	Perimeter Unit Analisis	Luas Unit Analisis
Unit 1	568,2	18.855,9
Unit 2	628,1	13.686,9
Unit 3	553,1	12.719,8
Unit 4	669,6	18.384,5
Unit 5	512,1	9.104,1
Unit 6	513,8	8.713,4
Unit 7	435,5	7.555,1
Unit 8	581,5	13.150,7
Unit 9	486,3	10.735,7
Unit 10	510,4	11.512,9
Unit 11	721,1	21.148,1
Unit 12	559,4	14.252,7
Unit 13	589,4	14.098,9
Unit 14	585,4	14.638,9
Unit 15	557,1	13.976,9
Unit 16	578,6	14.904,5
Unit 17	494,0	12.795,5
Unit 18	449,9	10.414,7
Unit 19	471,6	10.882,6
Unit 20	555,5	12.714,8
Unit 21	742,0	20.652,2
Unit 22	412,2	8.084,0
Unit 23	481,1	10.902,6
Unit 24	579,2	13.902,7
Unit 25	458,7	9.774,5
Unit 26	335,4	4.959,7
Unit 27	392,0	7.212,2
Unit 28	361,7	6.307,1
Unit 29	400,4	7.987,5
Unit 30	422,0	10.392,2

2.5 Evaluation Results

The following is a summary of the evaluation scores for each unit using the respective measurement tools. The row for the design components contains the average values multiplied by the weight of each design component, and the points at the far right of the table represent the final scores of the analysis units.

Table 9-Result of Evaluation for each Unit

Unit Analisis	Luas Unit Analisis	Struktur Peruntukan Lahan	Intensitas Pemanfaatan Lahan	Tata Bangunan	Sistem Sirkulasi dan Jalur Penghubung	Ruang Terbuka dan Tata Hijau	Tata Kualitas Lingkungan	Prasarana-Utilitas	Actvity Support	Conservation / Preservation	Nilai akhir
Unit 1	18.855,9	0,69	0,18	0,39	0,89	0,34	0,31	0,73	0,20	0,15	3,97
Unit 4	18.384,5	0,53	0,24	0,39	0,70	0,27	0,19	0,65	0,20	0,15	3,60
Unit 24	13.902,7	0,48	0,30	0,47	0,54	0,25	0,14	0,73	0,23	0,15	3,52
Unit 12	14.252,7	0,59	0,22	0,33	0,60	0,20	0,12	0,84	0,15	0,15	3,44
Unit 16	14.904,5	0,48	0,22	0,30	0,70	0,21	0,15	0,79	0,20	0,15	3,41
Unit 13	14.098,9	0,48	0,26	0,33	0,63	0,21	0,13	0,79	0,15	0,15	3,35
Unit 25	9.774,5	0,40	0,18	0,44	0,54	0,24	0,13	0,76	0,23	0,15	3,29
Unit 15	13.976,9	0,48	0,26	0,30	0,60	0,18	0,11	0,79	0,15	0,15	3,29
Unit 14	14.638,9	0,69	0,22	0,33	0,41	0,13	0,05	0,68	0,15	0,15	3,25
Unit 17	12.795,5	0,43	0,22	0,28	0,54	0,15	0,08	0,79	0,18	0,15	3,17
Unit 19	10.882,6	0,43	0,18	0,28	0,63	0,17	0,11	0,73	0,18	0,15	3,13
Unit 29	7.987,5	0,48	0,18	0,44	0,30	0,13	0,04	0,73	0,15	0,15	3,11
Unit 9	10.735,7	0,48	0,26	0,22	0,65	0,14	0,09	0,79	0,20	0,09	3,09
Unit 23	10.902,6	0,29	0,22	0,17	0,73	0,12	0,09	0,73	0,18	0,15	3,09
Unit 8	13.150,7	0,48	0,20	0,28	0,65	0,18	0,12	0,60	0,20	0,15	3,07
Unit 18	10.414,7	0,43	0,18	0,28	0,46	0,13	0,06	0,79	0,18	0,15	3,05
Unit 21	20.652,2	0,29	0,18	0,28	0,65	0,18	0,12	0,73	0,18	0,15	3,03
Unit 20	12.714,8	0,29	0,18	0,28	0,60	0,16	0,10	0,79	0,18	0,15	3,02
Unit 3	12.719,8	0,37	0,18	0,33	0,65	0,22	0,14	0,68	0,20	0,09	2,96
Unit 22	8.084,0	0,40	0,18	0,28	0,41	0,11	0,05	0,73	0,15	0,15	2,92
Unit 2	13.686,9	0,37	0,26	0,33	0,54	0,18	0,10	0,68	0,20	0,09	2,91
Unit 11	21.148,1	0,48	0,22	0,22	0,41	0,09	0,04	0,68	0,15	0,15	2,87
Unit 28	6.307,1	0,45	0,18	0,44	0,30	0,13	0,04	0,70	0,15	0,15	2,87
Unit 30	10.392,2	0,29	0,10	0,44	0,51	0,23	0,12	0,68	0,18	0,15	2,84
Unit 10	11.512,9	0,48	0,26	0,22	0,41	0,09	0,04	0,68	0,15	0,09	2,75
Unit 27	7.212,2	0,37	0,06	0,33	0,30	0,10	0,03	0,68	0,15	0,09	2,44
Unit 6	8.713,4	0,43	0,20	0,33	0,35	0,12	0,04	0,38	0,15	0,15	2,42
Unit 5	9.104,1	0,56	0,12	0,33	0,35	0,12	0,04	0,38	0,15	0,15	2,42
Unit 26	4.959,7	0,28	0,10	0,33	0,27	0,09	0,02	0,68	0,15	0,15	2,29
Unit 7	7.555,1	0,45	0,12	0,33	0,32	0,11	0,03	0,38	0,15	0,03	2,17

Figure 6 - Visualisation of Evaluation Result

2.6 Key Physical Indicators Determining High-Scoring Analysis Units

The evaluation of the analysis units reveals that several key physical indicators significantly contribute to achieving high scores in sustainability, livability, regenerative, and neighborhood aspects. The sub-areas with the highest scores exhibit the following characteristics:

Table 10-Physical indicators of area with highest scores

Green Open Space (RTH)	Sub-areas with green open space exceeding 30% consistently score higher. This is evident in units such as 1 and 24, where ample green space contributes to ecological balance and enhances residents' well-being.
Efficient Circulation System	Sub-areas with high accessibility and well-developed pedestrian pathways received better ratings in the neighborhood and livability categories. Units 4 and 12 are prime examples, with well-integrated pedestrian pathways and cycling lanes that promote non-motorized transport.
Building Layout	Sub-areas with buildings designed to optimize natural airflow and lighting, such as unit 24, show higher comfort and livability scores.
Infrastructure and Utilities	Areas with well-established utility networks, such as drainage systems, clean water supply, and waste management, consistently achieved better performance. For instance, unit 16 demonstrated higher scores due to the presence of an integrated infrastructure network.

Conversely, sub-areas with the lowest scores tend to have limitations in public green spaces, inadequate non-motorized transportation infrastructure, and distances between public facilities exceeding the 500-meter standard. Sub-areas such as 26 and 7 exhibit deficiencies in these aspects.

2.7 Percentage of Units with Good and Very Good Scores

Based on the analysis, the evaluation categorizes units with scores between **3.1 and 5.0** as "Good" to "Very Good." The findings indicate:

Table 11 - Indications of Good to Very Good scoring

40% of the total sub-areas fall within the 'Good' to 'Very Good' category.
These sub-areas have successfully implemented sustainable urban planning strategies, such as improved pedestrian connectivity, efficient public transportation access, and green open space integration.
Units 1, 4, 12, 16, and 24 exemplify best practices in sustainability and livability criteria, achieving scores above 3.5.

2.8 Influence of Location within the Evaluation Area

The location of sub-areas within the study area plays a crucial role in their overall performance:

Central Sub-Areas Perform Better	Units situated in the central parts of the neighborhood tend to score higher due to better access to public amenities, transportation hubs, and green spaces. These areas are well-connected by pedestrian pathways and have a higher proportion of public facilities within a 500-meter radius.
Peripheral Areas Face Challenges	Sub-areas located on the periphery, such as units 26 and 7, scored lower due to limited green spaces, longer distances to essential facilities, and inadequate non-motorized transport infrastructure.
Proximity to Main Roads	Sub-areas along major roads (e.g., Jl. Wijaya I and Jl. Wolter Monginsidi) perform better in terms of accessibility and infrastructure quality, which contributes to higher livability scores. These areas benefit from a better public transport network and commercial facilities.

IV. CONCLUSION

This study presents an integrated approach to evaluating sustainability, livability, regenerative design, and neighborhood characteristics in the urban context of Petogogan Subdistrict, South Jakarta. The findings indicate that the application of these concepts has significant potential in enhancing the quality of urban environments by promoting ecological balance, social cohesion, and economic vitality. Key advantages of the study include the comprehensive use of a quantitative assessment framework, which facilitates a detailed understanding of the strengths and weaknesses of each sub-area within the neighborhood. The results highlight that areas with higher green open space proportions, efficient pedestrian circulation, and well-planned infrastructure consistently achieved better scores in sustainability and livability. Specifically, sub-areas with more than 30% green open space, such as units 1 and 24, demonstrated superior environmental performance and social well-being.

However, limitations of the study should also be considered. The reliance on secondary data sources and observational methods may introduce some degree of subjectivity in the assessment process. Additionally, the use of the Likert scale, while providing a structured evaluation, may not fully capture the complexity of human experiences and perceptions regarding urban sustainability. Despite these limitations, the developed measurement framework offers a practical and scalable tool for urban planners and policymakers to identify priority areas for intervention and improvement.

The practical applications of this research extend to future urban planning initiatives aimed at optimizing land use, enhancing transportation infrastructure, and increasing the provision of public amenities. Policymakers can leverage these findings to develop targeted strategies that prioritize sustainability and livability, ensuring long-term resilience and well-being for urban communities. Future studies could explore deeper community engagement and real-time data monitoring to further refine the evaluation framework and support data-driven decision-making. Additionally, expanding the scope of research to include socio-economic variables could provide a more holistic understanding of urban sustainability challenges.

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