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ADVANCES IN SOCIAL HUMANITIES RESEARCH

Redefining the Role of the Private Sector in the Provision of Urban RTH: An Analysis of the Implementation of Green Building in NIPAH PARK Makassar

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Abstract

Rapid urbanization in Makassar, Indonesia, has contributed to a substantial deficit in urban green open space (Ruang Terbuka Hijau, RTH), which accounted for only 12.42% of the city's area in 2024, considerably below the 30% requirement stipulated in Law No. 26 of 2007, while built-up areas occupied approximately 75–80% of the urban landscape. This study examined how privately developed commercial infrastructure could function as socioecological infrastructure to help address the urban green space deficit. Employing a descriptive case study with a mixed-methods approach, the research integrated quantitative spatial analysis and qualitative architectural assessment of NIPAH PARK, an open-air commercial development in Makassar. Data were obtained from site plans, regulatory documents, field observations, and operational records. The findings revealed that NIPAH PARK provided 4,241.07 m² of landscaped green space (softscape), with a reported tree canopy coverage ratio of 98.21%, predominantly comprising broad-canopied species such as Terminalia mantaly and Samanea saman. Water conservation measures achieved reported savings of 90.24% in the mall and 89.57% in the office building. The development also functioned as an inclusive privately owned public space (POPS), providing publicly accessible jogging tracks, communal parks, pedestrian crossings, and wheelchair-accessible ramps, supported by systematic waste segregation and tenant fit-out regulations. The study concluded that integrating green building principles into commercial developments could contribute to ecological performance, economic value, and spatial equity. It further recommended that local governments expand conventional two-dimensional land-use planning to incorporate three-dimensional ecological considerations and introduce incentives to encourage compliance with green building standards.

INTRODUCTION

Rapid urbanization worldwide has fundamentally transformed the morphological and ecological structures of cities (Patel & Raval, 2024). Rapid urban population growth has accelerated the expansion of built-up areas and impervious surfaces, such as asphalt and concrete, resulting in the widespread loss of natural vegetation cover and contributing to the urban heat island (UHI) effect (Kumar et al., 2024; Wang et al., 2021). Rising urban

temperatures have adversely affected microclimatic conditions and public health while increasing energy consumption, particularly for air conditioning in tropical regions (Priya & Senthil, 2021). The building sector is also a major contributor to global energy consumption and greenhouse gas emissions (Yu et al., 2024). These challenges have made the transition toward environmentally sustainable architectural design increasingly important, extending beyond aesthetic considerations. Consequently, urban planning strategies must integrate built infrastructure with natural ecosystems to reduce ecological vulnerability in densely populated areas (Ronael & Oruç Ertekin, 2025).

In Indonesia, efforts to maintain urban ecological balance amid increasing urbanization pressures are regulated under Law No. 26 of 2007 concerning Spatial Planning (Republic of Indonesia, 2007). This regulation establishes a minimum allocation of 30% of urban areas for green open space (Ruang Terbuka Hijau, RTH), comprising 20% public RTH and 10% private RTH. However, substantial disparities remain between regulatory requirements and their implementation. Makassar, one of the major metropolitan areas and economic centers in eastern Indonesia, faces considerable challenges in maintaining adequate urban green space. In 2024, RTH accounted for only 12.42% of the city's total area, substantially below the minimum requirement established by national spatial planning regulations (Makassar City Government, 2024).

The limited availability of RTH is associated with the extensive development of residential, commercial, retail, and office areas, which collectively occupy approximately 75–80% of Makassar's urban landscape (Aldiansyah & Wardani, 2023; Mujahid et al., 2023). High land values and limited undeveloped land in central urban areas have constrained conventional approaches to RTH provision through land acquisition, potentially increasing the financial burden on local governments. These conditions highlight the need for more adaptive spatial planning strategies that extend beyond conventional ground-level green spaces and incorporate vegetation into existing buildings and developed urban environments.

Large-scale commercial developments, particularly shopping malls, have frequently been associated with environmental pressures, including high energy consumption, reduced natural water infiltration, and increased urban temperatures. Conventional commercial infrastructure may also contribute to the privatization of spaces traditionally used for public interaction (Gamal et al., 2024). Commercial environments that restrict access or prioritize consumption can limit opportunities for social engagement and recreation, particularly among low-income and vulnerable populations (Gupta et al., 2025). Consequently, the relationship between commercial development and equitable access to urban public spaces has become an important consideration in sustainable urban planning (Ntakana et al., 2025).

Nevertheless, contemporary urban design increasingly recognizes the potential of private commercial developments to contribute to public space provision. Through inclusive architectural design and appropriate management practices, commercial properties can incorporate privately owned public spaces (POPS) that support recreation, social interaction, and public accessibility without requiring visitors to engage in

commercial transactions (Jian et al., 2024; Shan et al., 2023). This approach offers opportunities to integrate private sector investment with broader urban sustainability and social inclusion objectives (Alkaujani et al., 2026).

Green building principles provide an alternative approach to addressing environmental challenges associated with limited urban land availability. These principles emphasize resource conservation, energy and water efficiency, waste reduction, and improvements in indoor and outdoor environmental quality throughout the building life cycle. Integrating blue-green infrastructure (BGI), including green roofs, green walls, and broad-canopied vegetation, can contribute to urban temperature regulation through shading and evapotranspiration (Cao et al., 2022; Mukhamedjanov et al., 2026). Such interventions may also reduce building cooling demand, improve stormwater management, and enhance urban ecological functions, depending on their design, scale, and environmental conditions (De Groeve et al., 2024; Kumar et al., 2024).

NIPAH PARK in Makassar represents a commercial development that incorporates sustainable architectural principles into its design. Unlike conventional enclosed shopping malls, NIPAH PARK adopts an alfresco architectural concept that integrates natural ventilation, landscaped green areas, and open communal spaces into its commercial environment. The development incorporates vegetation and publicly accessible recreational facilities, including jogging tracks, communal parks, and accessible infrastructure for people with disabilities. These features demonstrate the potential for private commercial properties to combine ecological functions with inclusive public space provision.

Although research on green buildings and green infrastructure has expanded considerably over the past decade, existing studies have frequently examined environmental performance through individual indicators, including energy efficiency, thermal regulation, and green facade performance (De Groeve et al., 2024; Priya & Senthil, 2021). Other investigations have emphasized urban-scale green infrastructure planning without sufficiently addressing the architectural characteristics of commercial developments in densely built environments (Wang et al., 2021). Meanwhile, urban social research has primarily focused on the accessibility of conventional publicly owned spaces, with comparatively limited attention to the ecological and social contributions of privately developed commercial environments (Arnberger et al., 2024; Selanon et al., 2025).

Furthermore, relatively few studies have comprehensively examined the integration of three interconnected dimensions within commercial developments: the ecological performance of green buildings, the economic considerations of private sector investment, and the social inclusiveness of POPS. The potential contribution of these integrated dimensions to addressing urban RTH deficits, particularly in densely populated tropical cities with limited available land, remains insufficiently explored. This research gap highlights the importance of examining commercial developments as potential components of broader urban green infrastructure systems.

Accordingly, this study aimed to examine how green landscape elements and sustainable architectural features were integrated into the commercial infrastructure of NIPAH PARK in Makassar. Specifically, the study evaluated the development's ecological characteristics, resource efficiency, and provision of accessible green spaces while assessing its potential contribution to urban RTH provision and environmental sustainability. By integrating spatial and architectural perspectives, the research sought to provide a more comprehensive understanding of the role of private commercial infrastructure in addressing urban green space challenges.

The findings were expected to provide empirical insights into the ecological performance and social inclusiveness of privately developed commercial spaces while informing urban planning policies and sustainable property development practices. By examining the relationship between green building implementation, private sector participation, and public space accessibility, the study sought to support more integrated approaches to urban sustainability. Collaboration between local governments and private developers could facilitate environmentally responsible urban development while expanding opportunities for equitable access to green and inclusive public spaces.

Research Objectives

This research is comprehensively designed to respond to the spatial planning crisis and ecological deficit in Makassar City. Currently, the availability of Green Open Space (RTH) has only reached 12.42%, which is very far from the mandate of Law Number 26 of 2007 which sets an ideal standard of at least 30%. Given the rapid expansion of built land, especially commercial infrastructure that dominates more than 75% of the urban area and often sacrifices natural catchment areas, this study makes NIPAH PARK a pilot *project*. Broadly speaking, the main objective of this research is to explore, analyze, and prove empirically that integrating large-scale green infrastructure into commercial building structures can be an instrument to mitigate the urban RTH deficit while restoring people's rights to inclusive public space.

More specifically, the first objective of this study is directed at the spatial analysis and evaluation of the ecological performance of green *buildings* in NIPAH PARK. This study aims to quantify the application of *Blue-Green Infrastructure* elements in commercial areas, by evaluating the cover ratio of tropical vegetation canopy shaded by structure-free areas (*softscape*). This study also aims to measure the efficiency of building utility resource management, such as the estimated water facility savings rate of more than 89%. Through the measurement of these spatial parameters, the study aims to prove academically that private commercial buildings are not always a thermal load that worsens the microclimate. Furthermore, the building can reduce the effect of *the Urban Heat Island* (UHI) and act as an artificial ecological restoration area amid urban density.

The second objective is focused on the socio-cultural dimension, namely to examine the effectiveness of transforming exclusive commercial property into *Privately Owned Public Space* (POPS) that prioritizes social inclusivity. This study is aimed at evaluating universal design elements in NIPAH PARK that accommodate accessibility for all levels of society, especially the fulfillment of physical connectivity for vulnerable groups or

persons with disabilities (disabilities) through the availability of integrated pedestrian paths, ramps, and *zebra crosses*. This goal is crucial to prove that private space is able to break down barriers to economic transactions by providing free communal facilities. Furthermore, this analysis aims to see how artificial landscapes in commercial areas can support attention *restoration theory* and stress reduction for urban communities alienated from nature.

The third objective is to synthesize these spatial and sociological findings to formulate an implementable spatial planning policy direction framework for the Makassar City Government. Through an in-depth understanding of the contribution of private RTH, this study aims to develop regulatory recommendations that support collaboration between the government and property developers. This includes the proposal of a special incentive scheme for the private sector that is committed to implementing green building standards holistically. Ultimately, the achievement of all the objectives of this research is expected to be able to offer a new paradigm for urban planners in the tropics, that horizontal land limitations can be overcome by the intensification of vertical RTH that synergizes capital value, ecological preservation, and social justice for the entire community.

METHOD

This study employed a descriptive case study design using a mixed-methods approach that integrated quantitative spatial analysis and qualitative architectural assessment. The approach was designed to examine how commercial infrastructure could incorporate ecological spaces. The analysis focused on measuring the extent and distribution of green spaces and evaluating public space inclusivity and building performance from urban design and spatial planning perspectives.

The study was conducted at NIPAH PARK in Makassar, Indonesia, which was purposively selected for its distinctive architectural and spatial characteristics. The development adopted an alfresco architectural concept and green building principles, integrating open corridors, natural ventilation, and landscaped green spaces into its commercial infrastructure. Unlike conventional enclosed shopping malls, NIPAH PARK incorporated publicly accessible areas and vegetation within its built environment. These characteristics made it a relevant case for examining the potential contribution of private commercial developments to urban green open space (Ruang Terbuka Hijau, RTH) provision, particularly in relation to the 10% private RTH allocation stipulated in Indonesian spatial planning regulations.

The study used spatial data, regulatory documents, and field observations. Spatial data included horizontal and vertical green coverage, the proportion of built-up areas to open spaces, and building site plans. Regulatory data included Law No. 26 of 2007 concerning Spatial Planning and municipal RTH statistics, which indicated that green open space accounted for 12.42% of Makassar's total area. Field observations focused on public space accessibility and inclusivity, particularly the availability and accessibility of

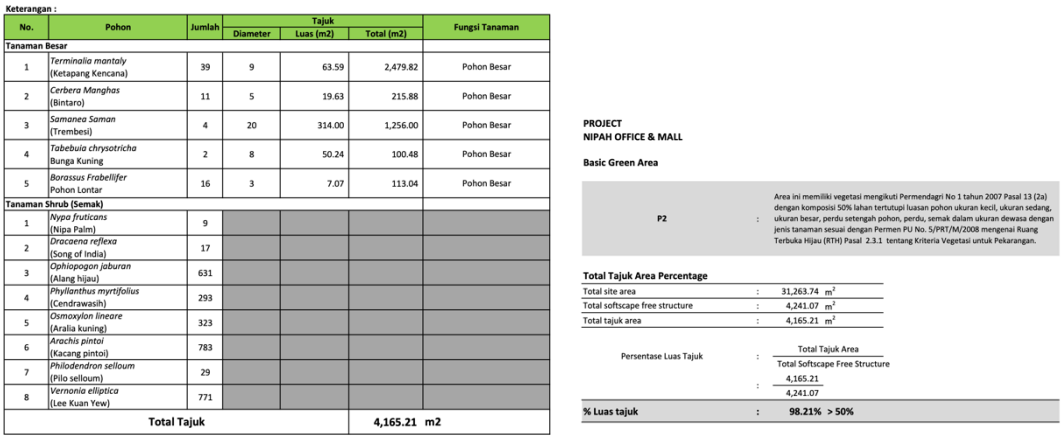
facilities such as jogging tracks, bicycle parking areas, and communal corridors that could be used without requiring commercial transactions.

Data were analyzed in three stages. First, spatial and building morphology analyses were conducted to quantify green space coverage within NIPAH PARK and assess its potential contribution to private RTH provision. Second, ecological integration and social inclusivity were evaluated through observations of natural ventilation, landscaped areas, public space utilization, and physical accessibility. Third, the findings were compared with relevant spatial planning regulations to identify potential policy implications for private sector participation in urban green space provision. This analysis provided a basis for assessing the applicability of integrated green building strategies to other commercial developments and identifying regulatory measures that could encourage private sector contributions to addressing Makassar's RTH deficit.

RESULTS AND DISCUSSION

Application of Green Building Elements in NIPAH PARK: Integration of Architecture and Ecology

NIPAH PARK displays a form of architectural intervention that significantly changes the typology of conventional shopping centers which are generally massive and closed. Based on the spatial analysis of the site, from the total area of 31,263.74 m², NIPAH PARK is recorded to allocate a soft *structure* green area of 4,241.07 m². This figure is not just an aesthetic complement, but functions as an artificial ecosystem with a total crown cover area of 4,165.21 m², or equivalent to a crown cover ratio of 98.21% to *the softscape* area. This achievement that exceeds the minimum limit of 50% shows NIPAH PARK's compliance with Permendagri No. 1 of 2007 regarding vegetation criteria. The selection of vegetation species also shows an ecologically calibrated landscape design, including 39 ketapang kencana trees (*Terminalia mantaly*) and trembesi trees (*Samanea saman*) as giant canopy shades. In addition, the landscape design is also combined with layered shrub vegetation such as *Nypa fruticans* and *Lee Kuan Yew* which function as pollution filters and microtemperature reducers.



Keterangan :

No.	Pohon	Jumlah	Tajuk			Fungsi Tanaman
			Diameter	Luas (m2)	Total (m2)	
Tanaman Besar						
1	*Terminalia mantaly* (Ketapang Kencana)	39	9	63.59	2,479.82	Pohon Besar
2	*Cerbera Manghas* (Bintaro)	11	5	19.63	215.88	Pohon Besar
3	*Samanea Saman* (Trembesi)	4	20	314.00	1,256.00	Pohon Besar
4	*Tabebuia chrysotricha* Bunga Kuning	2	8	50.24	100.48	Pohon Besar
5	*Borassus Frabellifer* Pohon Lontar	16	3	7.07	113.04	Pohon Besar
Tanaman Shrub (Semak)						
1	*Nypa fruticans* (Nipa Palm)	9				
2	*Dracaena reflexa* (Song of India)	17				
3	*Ophiopogon jaburan* (Alang hijau)	631				
4	*Phyllanthus myrtifolius* (Cendrawasih)	293				
5	*Osmoxylon lineare* (Aralia kuning)	323				
6	*Arachis pintoi* (Kacang pintoi)	783				
7	*Philodendron selloum* (Pilo selloum)	29				
8	*Vernonia elliptica* (Lee Kuan Yew)	771				
Total Tajuk					**4,165.21 m2**	

PROJECT
NIPAH OFFICE & MALL

Basic Green Area

P2	:	Area ini memiliki vegetasi mengikuti Permendagri No 1 tahun 2007 Pasal 13 (2a) dengan komposisi 50% lahan tertutupi luasan pohon ukuran kecil, ukuran sedang, ukuran besar, perdu setengah pohon, perdu, semak dalam ukuran dewasa dengan jenis tanaman sesuai dengan Permen PU No. 5/PRT/M/2008 mengenai Ruang Terbuka Hijau (RTH) Pasal 2.3.1 tentang Kriteria Vegetasi untuk Pekarangan.

Total Tajuk Area Percentage

Total site area	:	31,263.74 m^2
Total softscape free structure	:	4,241.07 m^2
Total tajuk area	:	4,165.21 m^2
Persentase Luas Tajuk	:	Total Tajuk Area / Total Softscape Free Structure
	:	4,165.21 / 4,241.07
% Luas tajuk	:	**98.21% > 50%**

Figure 3. Title Area Data in NIPAH PARK

Beyond the horizontal landscape aspect, NIPAH PARK's architectural innovation lies in the application *of an alfresco* concept that breaks the thermal insulation of commercial buildings. Structurally, this building integrates an open corridor with *a void elevator* layout and a plaza designed to facilitate natural cross-air circulation. Meanwhile, in terms of water circulation management, NIPAH PARK proves a real commitment to resource efficiency through the application of high-specification *water fixtures* that are below the maximum exhaust standards. Based on operational data, this innovation results in very drastic and significant water use efficiency. The water saving rate that has been achieved has touched 90.24% in mall facilities and 89.57% in office areas. This performance metric directly answers the criteria for green building energy efficiency certification (WAC-2.1C).

In addition to optimization in the utility sector, NIPAH PARK also integrates nature into its architecture through an ecological approach. The widespread use *of green roof* or "green land" elements in the upper area of the building, from the H1 to H7 floors as well as the provision of *water splash areas*, further emphasizes the integration of micro-hydrological cycles into the concrete structure of buildings. Through the combination of water-saving technology and adaptive green landscapes, this building can be considered successful in transforming urban commercial areas into sustainable socio-ecological infrastructure.

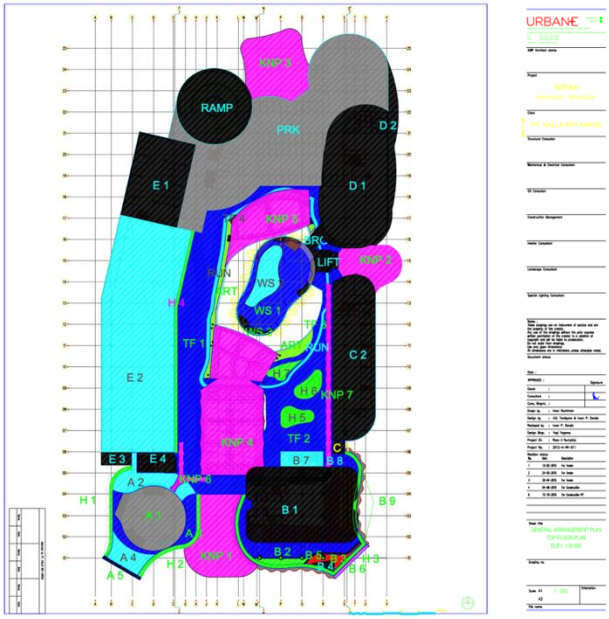


Figure 4. Hydrological Cycle in the Structure of NIPAH PARK Building.

Contribution to City RTH: NIPAH PARK as Spatial Mitigation

The decrease in the percentage of Green Open Space (RTH) in Makassar City, which currently touches a critical figure of 12.42% of the city's area, is a direct impact of the rapid expansion of commercial and residential areas. The dominance of built-up land that reaches more than 75% to 80% not only erodes ecological carrying capacity, but also creates spatial barriers where the provision of new horizontal RTH through land acquisition becomes very expensive and unrealistic. In this spatial emergency, NIPAH

PARK demonstrates that the commercial private sector is not always a destroyer of ecological balance. The presence of this commercial entity is transformed into a very strategic spatial mitigation instrument. Instead of covering the entire site with the watertight concrete structure that triggered *the Urban Heat Island* (UHI), NIPAH PARK proactively integrates green infrastructure into its building morphology. This effort demonstrates spatial interventions that directly reduce the negative impacts of urban density.

The ecological contribution of NIPAH PARK can be validated quantitatively through its very significant allocation of open space in the city center. Based on the calculation of site data, from the total *site area* of 31,263.74 square meters, the developer dedicated a *softscape free structure* area of 4,241.07 square meters. More essentially, the quality of this private RTH is dominated by tree elements with a wide canopy that results in a total crown cover area of 4,165.21 square meters. This represents a crown cover ratio of 98.21% to softscape areas, an achievement that exceeds the minimum limit of 50% required by regulations related to yard vegetation criteria. This massive crown area of dominant vegetation such as ketapang kencana (*Terminalia mantaly*) and trembesi (*Samanea saman*) plays a vital role in facilitating the evapotranspiration process, filtering pollutant particles, and regulating the microclimate in these traffic-heavy areas.

Conceptually and practically, the contribution of NIPAH PARK's green area should not be reduced in significance to simply meet the administrative obligations of 10% private RTH mandated by law. NIPAH PARK offers a spatial mitigation framework that empirically proves that the intensification of commercial land in urban centers can be offset by ecological intensification. The more than 4,100 square meters of canopy serves as an "ecological lung" that actively absorbs operational carbon emissions from surrounding commercial activities. This is in line with the urban sustainability literature that confirms that massive integration of vegetation into green infrastructure is capable of modifying the microclimate through shading and evaporative cooling. This effort can significantly lower the thermal load of an area. Ultimately, the spatial mitigation strategy executed by NIPAH PARK sets an important precedent for urban designers. This strategy emphasizes that the compromise between maximizing the economic value of land and restoring urban RTH can be achieved harmoniously through ecologically sound commercial architectural design.

Commercial Transformation into Inclusive Privately Owned Public Space (POPS)

The success of NIPAH PARK is not only measured by its ecological performance, but also by its success in revolutionizing the role of the private sector in providing social infrastructure. Theoretically, commercial buildings such as malls are often criticized for privatizing collective space and creating social exclusion based on capital transactions. However, the findings in NIPAH PARK affirm the discourse of Chiodelli and Moroni (2015), who view that shopping malls can be transformed into *highly open Privately Owned Public Space* (POPS). This means that the public has the right to access and interact in them without the obligation to spend money. This is empirically proven through

the provision of free recreational facilities such as running *tracks*, bicycle parks, and communal spaces that blend with the artificial nipah forest landscape.

In addition to removing economic barriers, a crucial parameter of an inclusive public space is the guarantee of physical accessibility for all levels of society, especially for vulnerable groups and persons with disabilities (disabled). Based on an analysis of NIPAH PARK's site plan document, the building implements universal design principles that carefully break down spatial barriers. Accessibility for people with disabilities is designed in an integrated and sustainable manner, starting from the point of arrival at public transportation stops and public pedestrian paths. The mobility of these vulnerable groups is accommodated through the provision of *a special zebra cross* that serves as a pedestrian replacement crossing route to provide direct connecting access to the building plaza. Furthermore, the elevation transition from the plaza area is facilitated using a pedestrian *ramp infrastructure* that is directly shaded by a shade tree canopy. This architectural approach ensures that the circulation of movement of people with disabilities can be passed safely, comfortably, and thermally shaded.

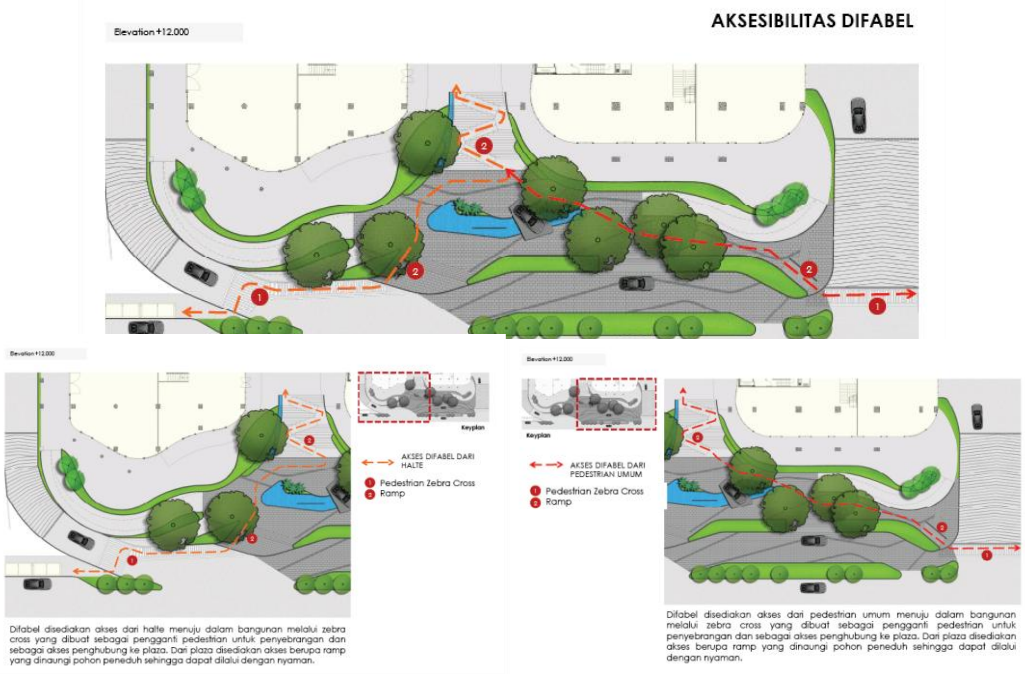


Figure 5. NIPAH PARK Disabled Access Map

This friendly physical connectivity answers access problems for marginalized groups, while meeting the criteria for socially inclusive public spaces. The successful combination of ecological facilities and social inclusivity guarantees confirms that the economic value creation of a commercial property does not have to sacrifice public social rights at all. NIPAH PARK demonstrates that with a commitment to urban design that prioritizes universal accessibility, the private sector is able to proactively fill the void of the government's role in providing communal collective space. This architectural transformation provides empirical evidence that high-density commercial land can be

intelligently engineered into socio-ecological infrastructure that not only helps to reduce the deficit of Green Open Space (RTH), but also restores equal spatial justice for all elements of urban society.

Infrastructure and Systematic Waste Processing Mechanism

In the green architecture paradigm, the ecological efficiency of a commercial building is not only measured from passive design and the availability of green open space alone, but also highly dependent on the capacity of the infrastructure in managing its operational residue. NIPAH PARK in Makassar City has laid the foundation for comprehensive environmental governance through the implementation of a systematic solid waste management mechanism. Based on the Standard Operating Procedures (SOP) document for Waste Management implemented by management, the hierarchy of waste management in this area is firmly oriented towards mitigating environmental impacts and optimizing resource circularity. This approach is a manifestation of compliance with the principle of sustainability, where waste management interventions are carried out preventively from the source of generation (upstream) to prevent the mixing of materials that can ultimately hinder the decomposition and recycling process.

The sorting mechanism is implemented in a spatially structured manner by dividing the zoning of waste sources into two main functional clusters, namely public areas for visitors (malls) and private areas for tenants (offices). In these two clusters, the provision of infrastructure is required to facilitate initial segregation into three specific categories. Organic waste that can undergo weathering is allocated to green bins, while inorganic waste in the form of synthetic products that cannot be decomposed by nature is allocated to yellow bins. In addition, Hazardous and Toxic Materials (B3) waste is allocated to red bins. To ensure the consistency of this material separation, the operational chain is continued by the Housekeeping unit which is in charge of transporting waste separately based on its type using a special trolley. This isolated transport system effectively minimizes the risk of cross-contamination before the waste reaches the building's internal Temporary Shelter (TPS). Upon arrival at the landfill, each category of waste is required to go through the "Record and File" procedure, an essential quantitative data collection mechanism to monitor and evaluate the volume of daily waste generation before it is finally distributed to third parties for the final recycling or processing process.

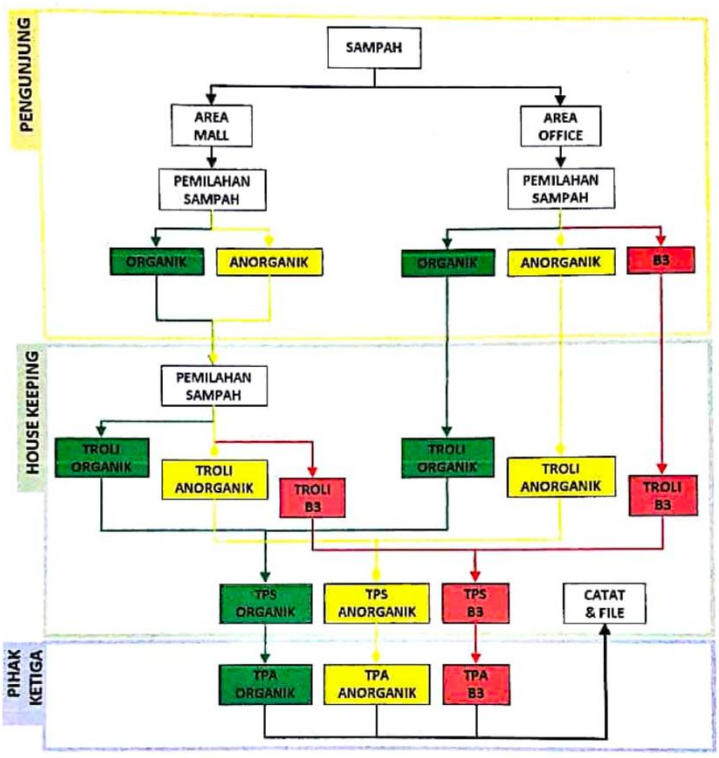


Figure 6. NIPAH PARK Waste Sorting Flow

Furthermore, NIPAH PARK's sustainability commitment is not only limited to daily operational waste, but also extends to construction waste management. In the shopping center ecosystem, the cycle of tenant turnover often triggers a high volume of waste from interior work or fitting out. Through strict fitting out regulations, building management mitigates the potential for environmental degradation by prohibiting the use of hazardous materials; for example, tenants are required to use non-asbestos materials such as gypsum for the ceiling, and are required to use certified legal wood materials. Operationally, management strictly isolates the disposal lines of construction debris. Debris and project waste from tenants are not allowed to be disposed of in conjunction with the building's regular TPS, but it is the absolute responsibility of the contractor to immediately evacuate outside the building area in accordance with the direction of the coordinator.

This integration between strict domestic waste segregation and prescriptive construction waste regulation demonstrates a holistic property management framework. The application of this procedure directly responds to the Material Resources and Cycle (MRC) criteria in green building standardization, where large-scale commercial entities are able to be engineered into facilities that proactively reduce their ecological footprint. Through the standardization of sorting from upstream to downstream, NIPAH PARK is seen as successfully establishing a responsible commercial ecosystem, which directly implicates a significant reduction in the final residue load that must be sent to the city's Final Processing Site (TPA) facility.

CONCLUSION

This study provides empirical insights into the potential role of private commercial developments in addressing urban green open space (Ruang Terbuka Hijau, RTH) deficits in tropical metropolitan areas. The expansion of commercial, residential, and transportation infrastructure, which occupies approximately 75–80% of Makassar's urban area, has constrained opportunities for conventional green space provision through land acquisition. With RTH accounting for only 12.42% of the city's total area, alternative approaches to integrating vegetation into existing built environments have become increasingly important. The findings indicate that incorporating green infrastructure into commercial architectural design, as demonstrated by NIPAH PARK, offers a complementary strategy for improving urban ecological conditions and expanding green space provision.

The spatial analysis revealed that NIPAH PARK incorporated 4,241.07 m² of landscaped green space (softscape), with a reported vegetation canopy coverage ratio of 98.21%. The landscape was characterized by broad-canopied tree species, including Terminalia mantaly (ketapang kencana) and Samanea saman (trembesi). These species can contribute to microclimatic regulation by providing shade, intercepting solar radiation, and facilitating evapotranspiration. The integration of vegetation into the commercial development demonstrated the potential of landscape-oriented architectural design to support urban ecological functions within densely built environments.

The findings further indicated that green building performance extended beyond vegetation coverage to include resource conservation and operational efficiency. NIPAH PARK incorporated water-efficient plumbing fixtures and resource management practices, with reported water savings of 90.24% in mall facilities and 89.57% in office facilities relative to the assessment benchmarks. These measures demonstrated the potential for substantial reductions in building water consumption and associated operational demands. Reduced water consumption may also decrease the energy required for water supply and distribution, depending on system characteristics. Furthermore, the development's alfresco architectural design integrated open circulation areas, natural ventilation, and landscaped spaces, potentially contributing to improved outdoor thermal conditions and reduced dependence on mechanical cooling in applicable areas. Collectively, these features suggest that integrating passive architectural strategies and green infrastructure into commercial developments may help mitigate localized urban heat island (UHI) effects, although direct thermal and carbon emission reductions require further measurement.

From a social and urban design perspective, the findings highlighted the potential for commercial developments to provide accessible public spaces despite increasing land scarcity and economic pressures. NIPAH PARK incorporated features consistent with the concept of privately owned public spaces (POPS), integrating recreational and communal facilities into a privately developed commercial environment. The site provided pedestrian connections, designated pedestrian crossings, accessible ramps, communal

spaces, jogging tracks, and bicycle parking facilities. These features supported physical accessibility and opportunities for public use without requiring commercial transactions. The integration of accessible circulation routes and recreational facilities demonstrated how private commercial properties could contribute to more inclusive urban environments. However, the extent to which these facilities improved spatial equity, social cohesion, and user well-being would require further assessment through accessibility audits and user-based evaluations.

The integration of ecological, operational, and social considerations in this case study offers several implications for urban planning and private sector participation in Makassar. Local governments could consider complementing conventional land-based RTH planning with policies that encourage vegetation integration into building structures and commercial developments. Such approaches should account for applicable RTH classifications, building regulations, and environmental performance standards. Potential policy instruments include incentives related to the floor area ratio (Koefisien Lantai Bangunan, KLB), streamlined permitting procedures, and property tax incentives for developments that meet verified green building standards and provide accessible public spaces, subject to applicable legal and administrative requirements. For property developers, integrating green infrastructure and inclusive public spaces may offer opportunities to improve resource efficiency, enhance the quality of commercial environments, and strengthen long-term property value. Nevertheless, the economic benefits of these strategies, including reduced maintenance costs and increased visitor activity, require further empirical evaluation.

Despite its contributions, this study had several limitations. The assessment relied primarily on descriptive spatial analysis, document review, and architectural observations within a single commercial development, limiting the generalizability of the findings to other building typologies and urban contexts. Furthermore, the study did not directly measure microclimatic variables, including ambient air temperature, mean radiant temperature (MRT), wind flow patterns, or fine particulate matter concentrations (PM2.5). Consequently, the environmental benefits associated with vegetation coverage and passive architectural design could not be quantified comprehensively. Future research should incorporate field-based environmental monitoring, geospatial analysis, computational fluid dynamics (CFD), and microclimate simulation tools such as ENVI-met to evaluate thermal performance and air quality outcomes. User surveys and accessibility assessments would also provide additional evidence regarding public space inclusivity and social benefits. Moreover, life cycle assessment (LCA) could be employed to examine the embodied and operational environmental impacts of green building components, including their potential contributions to greenhouse gas emission reductions. These investigations would strengthen the evidence supporting the integration of green infrastructure into commercial developments and inform more effective strategies for environmentally sustainable and socially inclusive urban planning.

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CONFLICT OF INTEREST

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AUTHOR'S CONTRIBUTION

The author fully contributes to the formulation of the main idea idea, collects library data, analyzes and interprets the primary text of the figure, and prepares the manuscript. All authors have agreed on the final version of the manuscript.

GENERATIVE ARTIFICIAL INTELLIGENCE USAGE STATEMENT

The author states that generative artificial intelligence (AI) was used in the preparation of this manuscript. The author acknowledges the use of generative AI to help improve language clarity and improve the grammatical structure of the manuscript. The use is done in compliance with the applicable ethical guidelines regarding the use and disclosure of generative AI in scientific research. Each author has made substantial intellectual contributions to this work. The entire manuscript content has been carefully reviewed to ensure its accuracy, and the author is solely responsible for the integrity and final content of the manuscript.

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