

Assessing Site Management Practices in the Planning of a Market Building: A Case Study Based on Indonesian Green Building Regulations

Yatnanta Padma Devia, Laurin Atika Ozariyadi*, and Retno Anggraini

Abstract—Government infrastructure development plays a vital role in improving quality of life and supporting national development goals. In recent years, sustainable development principles, particularly those related to green building practices, have become increasingly relevant. However, these principles remain underutilized in certain public facilities, such as traditional markets. One critical yet often overlooked component is site management, which significantly affects environmental performance from the early planning stage. This study aims to develop a green building assessment framework specifically focused on site management in market building planning. Employing a qualitative descriptive research method with an applied approach, the study uses a case study of a market building in Indonesia, evaluated using site management criteria derived from Indonesian Green Building regulations. To ensure credibility, the framework and assessment are validated through expert judgment from professionals in green building and sustainable site planning. The results reveal that parking lot provision, site processing and accessibility, and private green open space planning are the most influential sub-parameters, contributing to the highest scores in the site management category. The case study building achieved a score of 23 out of 38, indicating a moderate level of compliance. However, deficiencies were identified in sub-parameters such as green open spaces and the lack of Electric Vehicle Charging Station (EVCS) facilities. This study contributes to the field by proposing a targeted, site-specific assessment framework for market buildings, a building typology that is rarely examined in green building literature. Integrating site management early in the design process can improve sustainability outcomes by enhancing public space quality and environmental awareness in urban communities.

Index Terms—Indonesia Green Building Regulations, Market Building, Site Management

I. INTRODUCTION

THE construction sector plays a fundamental role in national development by providing essential infrastructure that supports public welfare and economic growth. In recent years, sustainable construction has emerged as a central paradigm, adopted by many countries to address environmental, economic, and social concerns in the built environment [1]. One of the key strategies within this paradigm is the implementation of green building principles [2], which promote energy and resource efficiency, occupant well-being, and minimal environmental impact. In Indonesia, green building

practices have been formally regulated through the Ministry of Public Works and Housing Regulation (PERMEN PUPR) No. 21 of 2021 [3], which outlines seven core assessment parameters: site management, energy efficiency, water efficiency, indoor air quality, environmentally friendly materials, waste management, and wastewater management. A building that meets these criteria is recognized as having measurable performance in resource conservation, energy and water efficiency, and environmental responsibility.

Despite the presence of Indonesian green building regulations, the assessment of green building principles in Indonesia remains limited. Several challenges hinder the widespread adoption of green building assessments, including a lack of technical capacity among practitioners, inconsistent enforcement of regulations, and insufficient integration of sustainability principles in early-stage building planning. Moreover, assessments conducted under PERMEN PUPR No. 21 of 2021 have predominantly focused on large-scale institutional or residential buildings, such as universities, apartments, and places of worship. In contrast, traditional or public market buildings, which serve as critical urban infrastructure, have received considerably less attention.

While a number of studies have assessed buildings using Indonesian green building regulations, most have concentrated on academic or residential typologies [4–8]. Other research has applied international green certification systems, such as LEED, EDGE, and GBCI, to assess buildings in Indonesia [9–13]. In the context of public markets, only a few studies, including those by Saraswati et al. [9], Janiawati et al. [10], and Solikan et al. [11], have explored environmental assessments, often referring to earlier national standards or third-party rating systems rather than the latest national regulation. Globally, green-certified public markets remain rare, although there are notable cases such as the Boston Public Market [14], which successfully integrated energy-saving and waste-reduction strategies within a heritage context under LEED certification. This scarcity of examples highlights both the opportunity and urgency to advance green building practices in market buildings, particularly in developing countries such as Indonesia.

A more critical gap lies in the underrepresentation of the “site management” parameter in both academic literature and professional practice. Site management accounts for 23% of the total assessment score under PERMEN PUPR No. 21 of 2021, making it the second-highest weighted category after energy efficiency. However, most studies tend to emphasize technical

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building systems, such as energy and water efficiency, while overlooking broader planning and design strategies that shape site performance. Key components of site management, such as accessibility, land use efficiency, microclimate regulation, stormwater management, and the provision of green open space, are often treated as secondary considerations. This omission undermines the holistic sustainability goals that green building frameworks aim to achieve.

Additionally, there is a lack of structured analytical frameworks dedicated to evaluating and improving site management performance within the context of national green building standards. The absence of such frameworks hinders designers, planners, and policymakers from developing actionable strategies tailored to specific building functions and local contexts. In particular, public markets, due to their high foot traffic, land utilization, and environmental footprint, require more thoughtful integration of site sustainability measures.

This study seeks to address these gaps by developing a green building assessment framework that focuses specifically on the site management parameter in the planning of market buildings. A case study of a market building in Indonesia is used to evaluate current site management practices against the criteria outlined in PERMEN PUPR No. 21 of 2021. Furthermore, the study proposes context-specific recommendations and strategies to enhance site sustainability performance, thereby contributing to more effective implementation of green building principles in public-use facilities. Through this approach, the study aims to inform future policy, planning, and design interventions that support sustainable urban infrastructure.

II. METHODS

This research adopts a qualitative descriptive approach with an applied case study design, aimed at developing a practical framework for green building site management assessment and evaluating its application in a real-world public market project. The methodology is structured into two main stages: (1) the development of a site management assessment framework based on national green building standards, and (2) its application in a case study involving a traditional market building in Indonesia.

A. Development of the Site Management Framework

The initial phase of the study involved the formulation of a green building site management framework derived from the official assessment parameters outlined in the Ministry of Public Works and Housing Regulation (PERMEN PUPR) No. 21 of 2021. This regulation specifies seven key criteria for green building certification, one of which is site management, comprising nine sub-parameters with a maximum score of 38 points.

To construct the framework, the regulatory criteria were reviewed and interpreted into a practical assessment structure that could be applied to public market buildings. These sub-parameters include aspects such as accessibility and connectivity, green open space, site vegetation, microclimate enhancement, and stormwater management.

The framework was designed to be both analytically robust and operationally applicable, serving as a tool for evaluating existing conditions and identifying areas for improvement.

B. Data Collection and Respondent Selection

Data collection in this study employed both qualitative and quantitative techniques to ensure a comprehensive understanding of the case context. Primary data were gathered through direct field observations, which captured the existing physical conditions of the site; semi-structured interviews with key project personnel involved in the planning and construction of Jongke Market; and the distribution of questionnaires to selected project participants. From a total population of 39 individuals involved in the project, 28 respondents were selected using the Slovin formula. The sample consisted of 1 project manager, 2 team leaders, and 25 technical staff.

The questionnaire items were directly based on the Simak List outlined in PERMEN PUPR No. 21 of 2021, which is recognized as an official reference document, thereby eliminating the need for additional validity and reliability testing. In addition to primary data, secondary data were collected from relevant project documentation, including architectural drawings, technical specifications, the Work Plan and Requirements (WPS), and the project organizational structure.

C. Expert Validation

To ensure the credibility and accuracy of the framework and its application, this study employed expert judgment involving two professionals with relevant expertise. The experts were selected based on specific criteria, including a minimum of five years of professional experience in green building design, planning, or assessment, and possession of officially recognized green building certifications at the Green Associate (GA) and or Green Professional (GP) level. Their role encompassed reviewing both the structure and content of the proposed framework, as well as validating the results obtained from the case study assessment, thereby enhancing the reliability and applicability of the research findings.

Accordingly, this study employed a triangulation strategy to enhance reliability that involved: (1) a systematic literature review aligned with PERMEN PUPR No. 21 of 2021; (2) data collection from 28 technical respondents; and (3) expert validation by two certified professionals.

D. Case Study Assessment and Recommendation Development

The second phase of the research applied the developed framework to a case study of Jongke Market, a public market located in Surakarta City, Central Java (Figure 1).

The market has a land area of 17,414 m² and consists of three floors accommodating 1,326 stalls. The building serves as a major economic hub in the western area of the city.

Using the framework, each of the nine sub-parameters under site management was evaluated to determine the

level of compliance with national standards. The performance of each sub-parameter was scored accordingly and then validated through expert review. Sub-parameters that met the standards were classified as compliant, while those that fell short were further analyzed.

Based on the findings, the study developed a series of context-specific recommendations aimed at improving site management performance. These recommendations address technical, spatial, and operational strategies to enhance environmental quality, user accessibility, and green infrastructure at the site level. The final outcome contributes to more effective implementation of green building principles in public-use facilities, particularly traditional markets, and informs future policy and design decisions related to sustainable urban development.

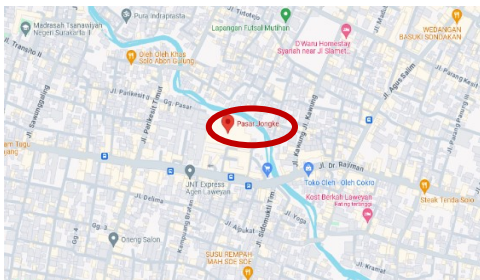


Fig. 1. The location of the public market.

III. RESULTS AND DISCUSSIONS

A. Site Management Framework

This study presents a systematic analysis of site management parameters within the green building planning framework, with a particular focus on their proportional contribution to the overall assessment score. The ranking provides insight into the relative weight and emphasis placed on various aspects of sustainable site planning, encompassing technical, environmental, and operational dimensions. By organizing the parameters in order of their quantitative significance, the study offers a clear foundation for understanding performance priorities and identifying areas that require policy refinement or design innovation, particularly in the context of public market development in Indonesia and Southeast Asia.

The ranking of site management parameters by their contribution percentages is presented below.

- 1) Provision of Parking Space (Score: 10, 26.32%). This parameter contributes the highest score, highlighting the importance of sustainable parking strategies. It encompasses the provision of adequate parking spaces, the use of permeable surfaces, the inclusion of electric vehicle charging stations (EVCS), and efforts to minimize land use through vertical or mechanical parking systems.
- 2) Site Processing Including Accessibility or Circulation (Score: 6, 15.79%). This parameter evaluates how well the site facilitates user accessibility and circulation. Key aspects include pedestrian flow, universal design elements, wayfinding signage, and vehicular

access, all of which are critical for enhancing functional efficiency and inclusivity.

- 3) Plan for Private Green Open Space (Score: 6, 15.79%). This parameter assesses the extent and quality of green open spaces within the private domain of the site. It includes canopy coverage, native vegetation, biodiversity support, and spatial arrangements that contribute to thermal comfort and ecological value.
- 4) Construction Above and/or Below Ground, Water and/or Public Infrastructure (Score: 5, 13.16%). This criterion addresses the interaction between buildings and existing underground or surface infrastructure. It emphasizes construction planning that avoids disruption to utilities, water flow systems, and public facilities.
- 5) Provision of Pedestrian Path (Score: 4, 10.53%). This parameter assesses the availability and quality of pedestrian routes within and around the building. It includes physical safety, surface quality, shading, and integration with urban pedestrian networks to promote walkability.
- 6) Management of Land Contaminated with Hazardous and Toxic Waste (Score: 3, 7.89%). This parameter focuses on land contamination management through site investigation and remediation. It ensures that developments on previously polluted sites meet environmental safety standards.
- 7) Building Orientation (Score: 2, 5.26%). This parameter evaluates building placement in relation to the solar path and prevailing winds to reduce cooling loads and enhance natural lighting. Orientation decisions significantly influence energy efficiency in tropical climates.
- 8) Basement Site Management (Score: 1, 2.63%). Evaluated only when a basement exists, this parameter focuses on stormwater control, erosion prevention, and groundwater infiltration, particularly important in flood-prone areas.
- 9) Outdoor Lighting System (Score: 1, 2.63%). This parameter emphasizes energy-efficient lighting with automatic sensors to reduce energy use and light pollution while ensuring safety.

The ranked framework provides a data-driven basis for prioritizing sustainable site management. Parking provision, site circulation, and green open space emerge as the highest priorities, highlighting the importance of mobility, land efficiency, and ecological considerations in green building projects. Infrastructure planning, basement management, pedestrian paths, and land contamination management rank at a moderate level, while building orientation, basement site management, and outdoor lighting systems receive lower emphasis. Figure 2 illustrates the systematic analysis of site management parameters within the green building framework, showing their relative weight and impact across technical, environmental, and operational dimensions.



Fig. 2. Site management in green building framework.

B. Case Study

1) Assessment result

a) Building orientation

This sub-parameter offers two assessment options. The first applies to buildings whose longest façade is oriented along the north–south axis, with a maximum deviation of 15°. The second applies to buildings whose longest façade faces the east–west direction and has a length at least twice that of the north–south orientation, provided that architectural or technical interventions are implemented on the building envelope (façade) and/or openings facing east and west. In the case of the market building analyzed in this study, the orientation shows an 8° deviation from the true north–south axis, with the north–south length measuring 190 meters and the east–west length measuring 138 meters (Figure 3). Based on these characteristics, the building meets the criteria of the first assessment option and is therefore awarded 1 point in accordance with the green building rating system.

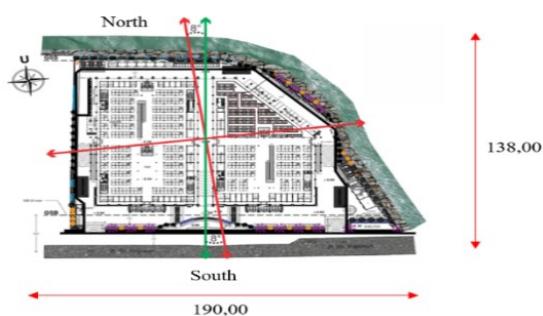


Fig. 3. Building orientation.

Building orientation is a key passive design strategy that significantly enhances thermal comfort and reduces energy loads for cooling and lighting, especially in tropical climates such as Indonesia. A north–south orientation improves natural ventilation and limits solar heat gain, contributing to climatic resilience by minimizing reliance on mechanical systems. However, site constraints, such as irregular plots, road alignment, or surrounding density, may hinder optimal orientation. These limitations can be

mitigated through design flexibility; buildings need not face directly onto roads but can be reoriented within site boundaries. For instance, aligning the longest façade along the east–west axis with a length ratio of more than 2:1 relative to the north–south side still qualifies for maximum points under green building criteria if supported by appropriate façade strategies. Thus, adaptability in site layout and planning is essential to achieving energy efficiency, and building orientation must be applied within a broader, context-sensitive site management framework.

These findings offer valuable insights for similar public market projects or dense urban developments in Indonesia and Southeast Asia, where space limitations and climatic challenges are common. Applying flexible orientation strategies in these settings can improve sustainability outcomes while ensuring compliance with national green building standards and regional environmental goals.

b) Site processing including accessibility or circulation

Roof covering and pavements that have a solar reflectance (albedo) score of at least 0.3.

The sub-parameter concerning roof covering and pavement with a minimum albedo score of 0.3 serves as an important passive design strategy to reduce surface heat gain and mitigate the urban heat island effect. Albedo quantifies a surface's ability to reflect solar radiation. In green building assessment, albedo scores are generally categorized as low (<0.3), moderate (0.3–0.6), and high (>0.6) [15].

In the case of Jongke Market, the building incorporates a combination of metal deck roofing, concrete roofing, and concrete pavement for non-roofed areas (Figure 4). Modern roofing materials such as metal decks are recognized for their inherent cool roof properties, characterized by low thermal mass and higher reflectivity, which reduce long-term heat retention and contribute to improved microclimatic conditions [15]. Based on these characteristics, the market qualifies for 1 point under this sub-parameter.

The average albedo score of the Jongke Market site was measured (Table 1) at 0.34, placing it within the moderate reflectivity category and meeting the minimum threshold set by the regulation. However, it is comparatively lower than the 0.39 albedo reported in the Gianyar Public Market in Bali [10], indicating that the surface materials used in Jongke Market are less effective in reflecting solar radiation. This comparison highlights a potential trade-off between material availability, aesthetic preferences, and thermal performance in public infrastructure projects. While the current materials used at Jongke Market offer functional compliance, they may not maximize thermal efficiency outcomes when compared to other best practices.

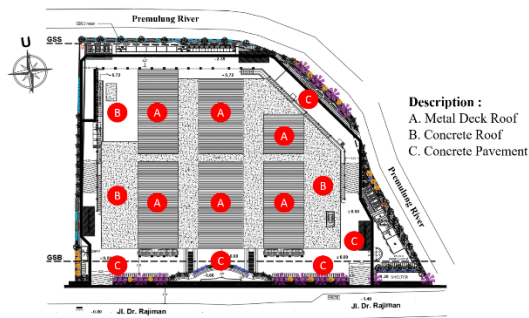


Fig. 4. Roof cover and pavement.

TABLE I
ALBEDO PARAMETER SCORE

Materials	Albedo (m ²)	Area (m ²)	Albedo × Area (m ²)
Roof Material			
Metal Deck Roof	0.61	3,944.00	2,405.84
Concrete	0.25	5,102.50	1,275.63
Non-roof Materials			
Concrete Pavement	0.22	5,034.85	1,107.67
Total		14,081.35	4,789.14
Albedo Score	4,789.14/14,081.35		0.34

In terms of robustness, this parameter is both quantifiable and widely applicable across diverse building types. Its adaptability stems from the availability of alternative materials that exceed the minimum requirement. For instance, replacing standard concrete with white concrete, high-albedo tiles, or applying cool pavement coatings can elevate surface albedo to 0.5–0.6 or higher, thereby enhancing heat reflectance and lowering surface temperatures [16]. Studies have shown that cool pavement technologies can reduce surface temperatures by up to 10–15°C and improve outdoor thermal comfort, particularly in dense urban environments [17].

These findings underscore the importance of prioritizing high-performance and durable material selection in the early planning stage. In traditional markets and urban settings across Indonesia and Southeast Asia, where thermal comfort and environmental resilience are crucial, the integration of high-albedo materials beyond minimum compliance

can significantly enhance sustainability outcomes. Additionally, incorporating higher performance benchmarks into local regulations may foster more climate-responsive design in public infrastructure. However, a notable limitation is the decline of albedo over time due to dirt accumulation, wear, and lack of maintenance. Regular cleaning and re-coating may be required to maintain performance, which may present operational challenges in public markets [18].

Rainwater captured across the entire site and building area (100%) must be managed for at least 2 hours using infiltration wells and/or retention or detention ponds that refer to the average daily rainfall over the last 10 years.

The rainwater management sub-parameter requires all site and building runoff to be retained for at least two hours using infiltration or detention systems. At Jongke Market, a system comprising 1 Ground Water Technology (GWT) unit, 2 Rainwater Harvesting Technologies (RHT), and 36 infiltration wells provides a storage capacity of 197.68 m³ and a discharge rate of 73.01 m³/hour, achieving a retention time of 2.7 hours. This meets regulatory standards and earns 2 points in the green building assessment.

This result illustrates a robust and scalable approach to decentralized water management, offering benefits such as flood mitigation, reduced runoff, and improved groundwater recharge. The results also demonstrate that context-sensitive rainwater management can be effectively implemented in traditional market environments. Compared to Gianyar Public Market [10], which lacked such infrastructure and received no points under the same criteria in the GBCI assessment, the Jongke case highlights the practical impact of integrated water strategies. While effective, the system’s performance depends on maintenance and site-specific conditions.

These findings suggest that integrating adaptable rainwater systems in traditional markets across Indonesia and Southeast Asia can enhance urban resilience, reduce infrastructure stress, and support regulatory improvement through performance-based green design. The use of rainwater can also reduce the negative environmental impacts of urban living and lower the energy burden typically associated with conventional water supply systems [19].

The score of the number of vegetation canopies compared to the site area is at least 20%.

The Jongke Market site occupies a total land area of 17,414 m², with 8,446.60 m² planned for vegetation canopy coverage, equivalent to approximately 49% of the site. This significantly exceeds the minimum 20% requirement stated in PERMEN PUPR No. 21 of 2021, thus earning the maximum score of 3 points under this sub-parameter. The proposed vegetation includes *Terminalia catappa* (beach almond), *Filicium decipiens* (fern tree), *Hibiscus rosa-sinensis* (hibiscus), *Bougainvillea* sp., *Oreodoxa regia* (royal palm), and *Cananga odorata* (cananga), selected for their wide

canopies and suitability for tropical urban environments (Figure 5, Table II).



Fig. 5. Vegetation canopies as publicly accessible green area.

TABLE II
VEGETATION PARAMETER SCORE

Name	Lead Dia. (m)	Face Area (m ²)	Number of Plants	Total Canopy Area (m ²)
	a	$b = \pi \times r^2$	c	d = b × c
<i>Ternanalia cattapa</i>	10	78.50	50	3,925.00
<i>Filicim decipiens</i>	12	113.04	20	2,260.80
<i>Hibiscus rosa-sinensis</i>	2	3.14	30	94.20
<i>Bougainvillea</i> sp.	2	3.14	60	188.40
<i>Oreodoxa regia</i>	6	28.26	40	1,130.40
<i>Cananga odorata</i>	6	28.26	30	847.80
Total vegetation canopy area				8,446.60
Land area				17,414.00
Vegetation canopy percentage = total canopy area/land area × 100%				49%

These species enhance site performance by providing shading, reducing surface and air temperatures, and contributing to microclimatic regulation through evapotranspiration, effectively mitigating urban heat island (UHI) effects [20–22]. However, implementation may face challenges on sites with limited ground space. In such cases, vertical gardens, green façades, and rooftop vegetation can offer alternative greening solutions that support biodiversity, thermal comfort, and aesthetic enhancement without requiring extensive land. Despite its benefits, this approach also presents limitations, including maintenance requirements, species adaptability, and seasonal variations in canopy density. Space competition in dense urban contexts may also restrict full implementation.

Comparatively, other traditional markets in Indonesia, such as those studied by Saraswati et al. [9] and Janiawati et al. [10], show lower canopy coverage due to limited planning or spatial constraints. The successful integration of nearly 50% vegetation canopy at Jongke Market demonstrates the feasibility of

structured greening strategies in similar settings. While current regulations emphasize area-based metrics, there is limited guidance on species selection or performance-based evaluation. Future regulatory revisions should incorporate functional criteria such as shading efficiency and thermal impact. These findings highlight practical strategies for replicating high-canopy coverage in public markets across Southeast Asia, advancing sustainable site management and urban resilience in tropical environments.

c) Management of land contaminated with hazardous and toxic material waste

This sub-parameter under PERMEN PUPR No. 21 of 2021 stipulates that green buildings constructed on previously contaminated sites are eligible for a maximum score of 3 points, provided that the land has undergone environmental restoration in accordance with prevailing regulations. Conversely, if a green building is constructed on land that is not contaminated by hazardous and toxic waste, no points are awarded. In the case of Jongke Market, the site was historically used as a market and is confirmed to be free of hazardous waste contamination.

Despite the favorable environmental conditions, the assessment under this sub-parameter resulted in a score of zero. This scoring framework, while designed to incentivize land remediation, introduces a potential trade-off in practice. Sites that are already environmentally compliant and do not require restoration are not rewarded, potentially discouraging the selection of cleaner, low-risk locations for public infrastructure development. From a regulatory standpoint, this raises critical questions regarding the fairness and logic of the scoring criteria. A more balanced and inclusive scoring approach could consider awarding credit for proactive site selection that avoids ecologically compromised land, thereby reinforcing the broader sustainability principles of green building design.

Adaptability in regulatory design would allow for a dual-path scoring system that both rewards remediation efforts and acknowledges responsible land-use practices. These findings underscore the need for future revisions of green building regulations to reflect a more holistic understanding of site conditions, especially in the context of urban development in Indonesia and Southeast Asia.

d) Plan for private green open space

Green area.

Under the sub-parameter for green area provision in the Indonesian Green Building regulation (PERMEN PUPR No. 21 of 2021), a site is awarded 1 point if its green area constitutes 10–20% of the total land area, 2 points for 20–50%, and 3 points for more than 50%. Jongke Market occupies a total land area of 17,414 m², with a designated green area of approximately 8,446.60 m². This results in a calculated green area percentage of 49%, which places the project within the 20–50% category, thereby earning a score of 2 points based on regulatory criteria.

However, during expert validation, a discrepancy arose. Experts argued that the effective green coverage exceeded 52%, particularly when including vegetated areas surrounding the market, such as those in the pedestrian shelter zones, which they contend should be classified as part of the functional green area. This suggests a need for clearer definitions within the regulation regarding what constitutes a “green area,” especially in urban contexts where landscape elements may serve multiple functions.

From a broader perspective, the Jongke Market case demonstrates how the interpretation of green area boundaries can influence scoring outcomes. For traditional markets or dense urban projects across Indonesia and Southeast Asia, where multifunctional land use is common, regulatory frameworks would benefit from integrating more flexible or performance-based assessment criteria. Recognizing functional green infrastructure, such as linear parks, bioswales, or vegetated transit zones, could incentivize innovative landscape design and contribute to urban cooling, biodiversity, and public comfort.

The planned green areas will be accessible to the public.

In the green building assessment framework outlined by PERMEN PUPR No. 21 of 2021, the sub-parameter concerning publicly accessible green areas awards 1 point if such spaces are designed to be open and usable by the general public. At Jongke Market, green areas are strategically located on the northern and southern perimeters of the site (Figure 5) and are physically accessible to visitors, fulfilling this requirement and earning a score of 1 point. These areas not only enhance user experience but also serve critical ecological and environmental functions. Public green spaces contribute significantly to urban microclimate regulation, facilitate air circulation, and provide natural shading that reduces ambient temperatures and heat stress. They act as carbon sinks through oxygen production and support stormwater management by facilitating rainwater infiltration and reducing surface runoff. Furthermore, these vegetated zones support biodiversity by offering habitats for various flora and fauna, mitigate pollution through natural filtration of air and water, and function as buffers against wind and noise disturbances [23]. The integration of accessible green spaces in the Jongke Market design highlights the feasibility and score of incorporating multifunctional landscapes in high-density urban markets.

These findings underscore the broader applicability of accessible green infrastructure in similar public market contexts across Indonesia and Southeast Asia. In cities where land is constrained and environmental stressors are increasing, designing publicly accessible green areas adjacent to community facilities can provide tangible benefits for human health, climate resilience, and social cohesion. To enhance impact, future regulations could evolve to include performance-based indicators such as usability, comfort, and ecological connectivity, ensuring that

public green areas are not only present but also meaningful in function and quality.

It is planned to plant vegetation that functions as shade, soundproofing, odor filters, or dust filters.

In accordance with the green building assessment criteria outlined in PERMEN PUPR No. 21 of 2021, the sub-parameter concerning vegetation with multifunctional ecological roles awards a maximum of 2 points if the planned vegetation serves more than one function, such as providing shade, reducing noise, filtering odors, or capturing dust particles [16]. In the case of Jongke Market, the landscape design successfully fulfills this criterion, earning a full score of 2 points. The selection of plant species was intentionally curated to ensure a diverse range of ecological services, as detailed in Table III.

TABLE III
VEGETATION CANOPY FUNCTION(S)

Name of Vegetation	Function(s)	Total Number of Functions
<i>Terminalia catappa</i>	Shade, Dust Filter	2
<i>Filicium decipiens</i>	Noise Barrier, Odor Filter, Dust Filter	3
<i>Hibiscus rosa-sinensis</i>	Noise Barrier, Odor Filter, Environmental Recognition	3
<i>Bougainvillea</i> sp.	Noise Barrier, Odor Filter, Environmental Recognition	3
<i>Oreodoxa regia</i>	Shade, Glare Barrier	2
<i>Cananga odorata</i>	Odor Filter	1

For instance, *Terminalia catappa* (sea almond) possesses a broad canopy that effectively provides shade, while its dense foliage aids in filtering airborne dust. *Filicium decipiens* (fern tree) features thick leaf clusters that function as effective noise barriers and particulate filters, while also helping to mitigate urban odors. *Hibiscus rosa-sinensis* and *Bougainvillea* sp. are widely recognized for their vibrant flowers and dense branching, making them effective in noise attenuation, odor absorption, and serving as visual cues that enhance environmental aesthetics. *Oreodoxa regia* (royal palm) serves dual roles as a shade provider and glare reducer due to its height and leaf orientation. *Cananga odorata* (ylang-ylang), known for its fragrant flowers, contributes to odor filtration and olfactory comfort in densely populated environments [24–28].

The multifunctionality of these selected species reflects a thoughtful and performance-driven approach to vegetation planning that extends beyond ornamental purposes. By integrating species with overlapping ecological functions, the project maximizes environmental benefits while optimizing spatial efficiency, which is an essential consideration in urban

markets with limited land availability. These findings demonstrate that multifunctional green infrastructure can be effectively implemented in traditional market environments and may serve as a replicable model for similar urban contexts across Indonesia and Southeast Asia. Policymakers and urban planners are encouraged to adopt this approach by emphasizing species selection based on functional ecological outcomes. Future green building guidelines could also benefit from incorporating standardized performance indicators related to vegetation function, enabling more rigorous and outcome-oriented landscape assessments in public infrastructure projects.

e) Provision of pedestrian path

Having a pedestrian path with a direction that provides access from the outside of the building to the building entrance and meets convenience requirements.

According to the Indonesian Green Building regulation (PERMEN PUPR No. 21 of 2021), the sub-parameter concerning pedestrian pathways awards a maximum of 3 points when a building provides a clear and continuous pedestrian route connecting the exterior of the site directly to the building entrance while meeting comfort and accessibility standards. In the case of Jongke Market, the main entrance is prominently positioned on the front façade and is equipped with directional signage that assists visitors in navigating the site efficiently. This ensures accessibility for first-time users, the elderly, and individuals with mobility challenges [29–30]. As such, the market satisfies the regulatory requirements and earns the full 3 points. The configuration of the pedestrian route and entrance design is illustrated in Figure 6 and Figure 7.



Fig. 6. Pedestrian area.

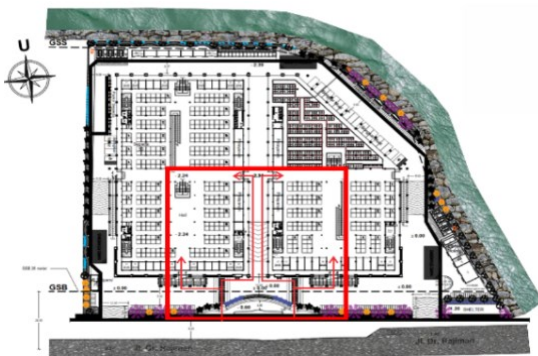


Fig. 7. Entrance.

The strength of this approach lies in its user-centered design, which enhances walkability, visibility,

and intuitive circulation. However, one limitation of the current regulation is its narrow focus on the physical presence and directional alignment of pathways, with limited attention to qualitative dimensions such as tactile guidance, weather protection, universal design features, or spatial legibility. A performance-based revision of the guideline could incorporate additional metrics, such as pathway continuity, shading, or inclusive mobility standards, to ensure more robust pedestrian experiences.

A notable trade-off emerges in balancing the need for direct pedestrian access with competing site demands, such as vehicle circulation, loading zones, or vendor frontage. This necessitates careful spatial planning and stakeholder engagement to optimize both pedestrian safety and operational functionality. The Jongke Market case demonstrates that high-quality pedestrian access can be integrated within a high-density urban market while achieving regulatory compliance and enhancing the user experience. These findings offer replicable strategies for improving accessibility in traditional market settings throughout Indonesia and Southeast Asia. In fast-growing cities where market infrastructure often lacks pedestrian prioritization, adopting well-marked, inclusive, and user-friendly pedestrian routes contributes to sustainable mobility, thermal comfort, and equitable access to public spaces.

Having pedestrian facilities that are connected to public facilities, such as public transportation, pedestrian bridges, public spaces, and surrounding plots or lots within a maximum distance of 400 m.

The sub-parameter concerning pedestrian connectivity stipulates that buildings should provide pedestrian facilities linked to public amenities such as public transportation, pedestrian bridges, public spaces, or adjacent plots within a maximum distance of 400 meters. In the case of Jongke Market, the pedestrian pathway directly connects to the Batik Solo Trans (BST) Shelter, thereby fulfilling this requirement and earning a score of 1 point. This integration facilitates efficient multimodal mobility, encouraging users to access the market via public transportation or on foot, thus contributing to reduced reliance on private vehicles and associated emissions. The pedestrian facilities at Jongke Market are designed to ensure safety, comfort, and direct access, as illustrated in Figure 8.

The strength of this approach lies in its alignment with transit-oriented development (TOD) principles, which promote compact and walkable communities centered on high-quality public transport systems [30–31]. However, a limitation of the current regulation is its emphasis on spatial proximity without adequately addressing qualitative aspects such as pedestrian comfort, shading, accessibility for persons with disabilities, and potential conflicts with vehicular traffic. Furthermore, the regulation does not incentivize enhancements such as integration with green corridors, wayfinding systems, or public realm improvements

that significantly influence pedestrian experience and usage patterns.

In the context of Southeast Asian urban environments, ensuring pedestrian linkage to public transport infrastructure is critical for promoting inclusive and sustainable mobility. The findings from Jongke Market underscore the importance of not only spatial proximity but also seamless physical and visual connections to surrounding transit networks. A more comprehensive regulatory approach incorporating performance-based indicators and universal design standards could yield higher-impact outcomes across diverse urban markets. These insights can inform urban planners and policymakers aiming to revitalize traditional markets and surrounding precincts into walkable and transit-connected environments that support health, accessibility, and climate goals. Such strategies are particularly pertinent for medium-sized cities striving to expand public transit use and reduce carbon footprints.

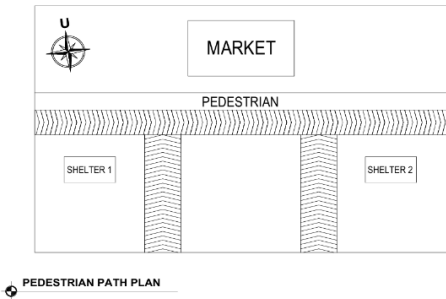


Fig. 8. Pedestrian path plan.

f) Basement site management

Under the green building assessment framework outlined in the Ministry of Public Works and Housing Regulation (PERMEN PUPR) No. 21 of 2021, the sub-parameter “Building Site Management” allocates 1 point if a building includes a basement that complies with the Basement Site Coefficient and facilitates rainwater infiltration, requiring a minimum depth of 4 meters from the surface. In the case of Jongke Market, the building does not include a basement; hence, no score was awarded under this sub-parameter.

This condition raises concerns regarding the equity and flexibility of the current assessment criteria. The absence of a basement in some cases, such as Jongke Market, may actually align with sustainable site management practices by avoiding deep excavation and preserving natural soil permeability, which are key components in promoting groundwater recharge and minimizing environmental disruption. Nonetheless, the current regulation does not recognize such environmentally conscious design decisions, as points are only awarded when basements are present and meet specific criteria.

The findings from this case study suggest the need for regulatory evolution toward a more inclusive and context-responsive framework. In densely populated urban markets across Indonesia and Southeast Asia, where land constraints, flood risks, and groundwater preservation are key challenges, promoting site designs without basements may prove more sustainable.

Therefore, adopting a performance-based assessment that evaluates how a building’s site planning contributes to rainwater absorption and ecological stability, regardless of structural typology, could lead to more equitable and environmentally aligned outcomes.

g) Provision of parking space

The building is planned to have a parking area of < 20% of the permitted Gross Floor Area (GFA) or have a mechanical parking system of <10% of the GFA.

The building is planned to have a parking area of less than 20% of the permitted Gross Floor Area (GFA) or to have a mechanical parking system of less than 10% of the GFA.

As presented in Figure 9 and Table 4, Jongke Market provides 1,725 m² of parking area, representing 7.03% of the total Gross Floor Area of 24,546 m². This satisfies the requirement of providing parking below 20% of GFA, thus earning the maximum score of 2 points. However, the market lacks both basement parking and vertical mechanical parking systems, resulting in no additional points under the sub-parameter.

Although the current surface parking design meets regulatory thresholds, future planning should consider integrating more space-efficient parking solutions, such as mechanical or structured vertical systems, to enhance land use efficiency. Given this parameter’s relatively high weight in the overall assessment, early-stage consideration is essential to optimize performance and ensure long-term alignment with green building standards. These findings from Jongke Market can inform broader urban infrastructure planning across Indonesian and Southeast Asian markets, where land scarcity, traffic congestion, and ecological resilience are central concerns [32].



Fig. 9. Parking area.

TABLE IV PARKING AREA CALCULATION		
Vehicle Type	Total Parking (parking space unit)	Parking Area (m ²)
Bicycle	48	72
Motorcycle	882	1323
Car	22	330
Total Parking Area (m ²)		1,725
Gross Floor Area (m ²)		24,546
Total Percentage (%)		7.03

Having facilities for bicycle users, namely bicycle parking and special bicycle lanes. The bicycle parking ratio is at least 1% of the number of users. Each additional 1% is given a score of 1 point, with a maximum score of 3 points.

The bicycle facility sub-parameter requires buildings to provide bicycle parking and dedicated lanes, with a minimum parking ratio of 1% of total users. Each additional 1% earns 1 point, up to a maximum of 3 points. At Jongke Market, 48 bicycle parking units serve 1,598 users, achieving a 3% ratio and earning the full 3 points (see Table 5 and Figure 10). This provision reflects a strong commitment to sustainable mobility, offering low-cost and space-efficient solutions that support health, reduce emissions, and enhance accessibility.

Despite its benefits, the current regulation focuses solely on quantity, without considering quality factors such as security, connectivity, or weather protection. Future policies should integrate qualitative measures to improve effectiveness and user experience. Given its impact on sustainability, incorporating well-designed bicycle infrastructure should be prioritized in future public market planning across Indonesia and Southeast Asia.



Fig. 10. Bicycle parking area.

TABLE V
BICYCLE PARKING AREA

Area	Maximum Occupancy (Person)
1st floor	729
2nd floor	565
3rd floor	304
Total Number of Occupancy (Person)	1,598
Number of Bicycle Parking (Unit)	48
Parking Ratio (%)	3,00

It has shower facilities for bicycle users with a ratio of two shower units for every 25 bicycle parking spaces.

The green building sub-parameter encourages the provision of shower facilities for bicycle users, with a standard ratio of two shower units for every 25 bicycle parking spaces. At Jongke Market, two shower units have been provided, thus meeting the minimum requirement and earning 1 point (Figure 11).

These facilities are essential to support cyclist comfort, particularly in tropical climates where

commuting by bicycle can result in physical discomfort due to heat and humidity. Although cycling culture in Indonesia remains relatively limited compared to more bicycle-oriented countries, the availability of supportive infrastructure, such as secure parking and shower facilities, can significantly encourage behavioral shifts toward sustainable transportation. As noted by Buehler (2012), the presence of end-of-trip facilities, including showers, positively influences the decision to commute by bicycle in urban contexts [33].

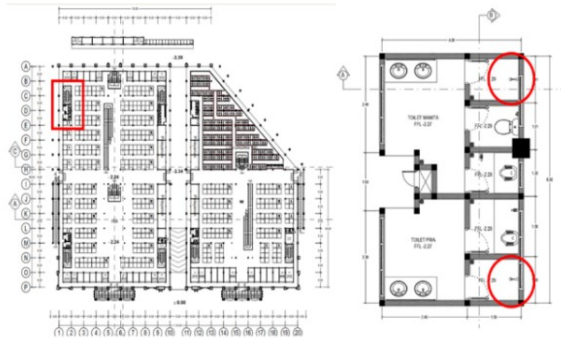


Fig. 11. Shower facilities.

Despite meeting the minimum provision, the current regulation does not address qualitative aspects such as accessibility, cleanliness, gender inclusivity, or user privacy, which are crucial for actual usage. A more robust and context-sensitive regulatory approach could enhance the effectiveness of this sub-parameter. In future public market developments, particularly in dense urban areas of Indonesia and Southeast Asia, prioritizing well-designed and accessible shower facilities can help increase the adoption of cycling, reduce carbon emissions, and contribute to healthier and more sustainable urban mobility systems.

The parking lot has facilities for Electric Vehicle Charging Stations (EVCS) with the provision of at least one EVCS unit for every 25 four-wheeled parking spaces and one EVCS unit for every 50 two-wheeled parking spaces.

According to the national green building criteria, buildings are eligible for 2 points if they provide Electric Vehicle Charging Stations (EVCS) at a ratio of one unit per 25 four-wheeled and one per 50 two-wheeled parking spaces. Jongke Market, however, lacks EVCS facilities and therefore received no score for this sub-parameter. While the adoption of electric vehicles in Indonesia is still limited, the inclusion of EVCS infrastructure is a crucial step toward promoting sustainable urban transport. Studies indicate that insufficient charging infrastructure remains a key barrier to EV adoption in the country [34].

From a regulatory perspective, the current scoring system does not accommodate readiness or future-oriented planning. Introducing partial points for EVCS-ready provisions, such as installed conduits or designated EV zones, could encourage early adoption. As electric mobility gains momentum, integrating EVCS into public infrastructure such as traditional markets will be essential to support decarbonization

goals and broader sustainability agendas in urban environments across Indonesia and Southeast Asia.

h) Outdoor lighting system

One of the key criteria for outdoor lighting in green building assessments is the integration of automatic sensors that control lighting operation based on environmental conditions. Optimizing daylight availability and automating lighting systems significantly contribute to reducing electricity consumption, particularly in commercial or public-use buildings. Integrating sensor technology and smart systems into prefabricated components can allow for real-time energy monitoring and management in completed buildings, enhancing long-term sustainability through operational efficiency [35].

In the case of Jongke Market, outdoor lighting has been equipped with motion and light sensors across several key areas, including garden spaces, vendor stalls, and visitor corridors. This qualifies the market to receive 1 point under this sub-parameter. The sensor installation layout is shown in Figure 12.

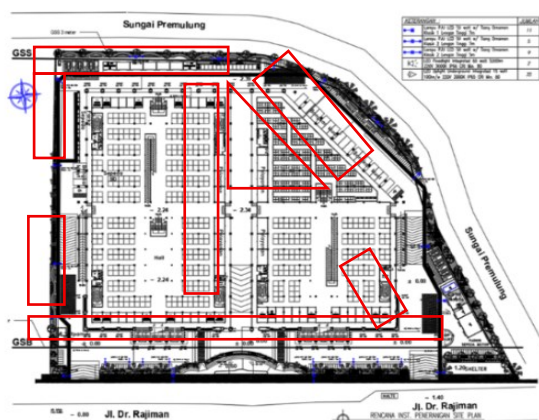


Fig. 12. Automatic lighting sensor installation plan.

Despite its straightforward implementation and measurable benefits, this sub-parameter is often overlooked in public market developments, mainly due to budget constraints or a lack of awareness regarding operational efficiency gains.

From a regulatory standpoint, current guidelines under PERMEN PUPR No. 21 of 2021 provide little incentive for broader deployment or integration of smart lighting technologies beyond basic compliance thresholds. A more progressive regulatory framework could include additional points for advanced control systems, such as adaptive dimming or energy monitoring features, to encourage innovation and deeper sustainability outcomes. Given the relatively low cost and high return on investment, the widespread adoption of automated outdoor lighting should be prioritized in future market planning.

In urban environments across Indonesia and Southeast Asia, where public infrastructure often operates for extended hours, automated lighting systems can yield substantial energy savings and reinforce the transition toward low-carbon cities. This case study demonstrates the potential for

replication in similar contexts and suggests that mainstreaming smart lighting systems can serve as a catalyst for sustainable public infrastructure development.

i) Construction of buildings above and/or below ground, water and/or public infrastructure or facilities

According to PERMEN PUPR No. 21 of 2021, the sub-parameter on building construction above or below ground, water, or public infrastructure is intended to prevent disruption to environmental and public utility systems. Jongke Market is constructed on a designated land area that does not intersect with underground infrastructure, water bodies, or shared public facilities. As a result, the building received no points for this parameter.

Although this aligns with current regulatory guidelines, it raises concerns about the fairness of the scoring method. Projects that responsibly avoid sensitive areas are not awarded points, whereas only those that remediate problematic sites are credited. This may unintentionally discourage environmentally sound site selection.

Given the significant weight this parameter holds in green building assessments, future regulatory revisions should consider rewarding both proactive and remedial strategies. Such a dual-path approach would better reflect the broader goals of sustainability and responsible land use. In the context of rapid urbanization in Indonesia and Southeast Asia, where development often overlaps with public infrastructure, these findings suggest a need for more nuanced and equitable evaluation criteria in green building certification systems.

2) *Aligning technical respondent insights and expert reviews in evaluating green market building*

The site management assessment for Jongke Market was conducted using inputs from 28 respondents and two green building experts, revealing consistent scoring patterns. Respondents assessed the market at 23 out of 38 points, while expert validation slightly adjusted the total to 24 points (63%). The only discrepancy arose in the green open space sub-parameter: respondents reported 49% coverage, whereas experts included the adjacent shelter area, resulting in 52%, which qualifies for the maximum score.

This consistency underscores the credibility of the instrument and reflects a moderate level of green building performance, particularly for public infrastructure constrained by dense spatial conditions. Strong performance was recorded in vegetation canopy, rainwater management, and pedestrian access, while sub-parameters such as basement planning, hazardous waste management, and EV infrastructure remained unfulfilled.

Expert validation, conducted by certified practitioners with a minimum of five years of experience and GA or GP credentials, confirmed the instrument's applicability. Their review verified the instrument's clarity, structure, and validity for measuring green performance in site management. While the assessments from respondents and experts generally aligned, the validation process

strengthened the instrument's scientific credibility and highlighted contextual nuances overlooked in the regulatory framework.

However, several limitations in the current regulatory framework (PERMEN PUPR No. 21 of 2021) were identified. For instance, rigid scoring penalizes buildings on uncontaminated land or without basement facilities, failing to recognize their inherently sustainable site conditions. Similarly, ambiguity in calculating green space coverage, particularly regarding infrastructure-adjacent areas, creates inconsistencies across assessments.

These findings suggest that the regulation may require typology-specific adaptations for public markets, which differ significantly from institutional or commercial buildings. Public markets, often embedded within urban neighborhoods, require flexible criteria that acknowledge community needs, spatial limitations, and operational realities. This study emphasizes the need for performance-based metrics that go beyond static thresholds, enabling broader application of green building principles in Southeast Asia's urban development context.

A detailed scoring breakdown by sub-parameter is presented in Table 6, highlighting key disparities and convergence across respondent and expert reviews.

TABLE VI
MARKET PLANNING STAGE PERFORMANCE ASSESSMENT RESULTS

Performance Assessment Parameters	Points	Technical Respondent Insight	Expert Review
Site Management			
Building Orientation	2	1	1
Site Processing Including Accessibility or Circulation	6	6	6
Management of Land Contaminated with Hazardous and Toxic Material Waste	3	0	0
Plan for Private Green Open Space	6	5	6
Provision of Pedestrian Path	4	4	4
Basement Site Management	1	0	0
Provision of Parking Space	10	6	6
Outdoor Lighting System	1	1	1
Construction of Building Above and/or Below Ground, Water and/or Public Infrastructure or Facilities	5	0	0
Total	38	23	24

3) Recommendations

An evaluation of the green building performance framework reveals that, within the Site Management parameter, the three sub-parameters with the highest potential scores are Provision of Parking Space (10 points), Site Processing Including Accessibility or Circulation (6 points), and Plan for Private Green Open Space (6 points). However, based on the Jongke Market case study, only Site Processing Including Accessibility or Circulation successfully achieved the maximum score, underscoring the importance of physical layout, spatial efficiency, and integrated circulation in public market planning. Conversely, Plan for Private Green Open Space scored 5 out of 6, while Provision of Parking Space reached only 6 out of 10 points.

This shortfall in parking provision is primarily due to the absence of Electric Vehicle Charging Stations (EVCS), which remain limited across most regions in Indonesia. Indonesia, through the State Electricity Company (PLN), targets the development of 6,278 EVCS units by 2025, while only 3,233 are currently available [36] (Figure 13). The lack of this infrastructure reduced the potential score, despite the otherwise compliant parking layout. This situation reflects a broader challenge in which regulations assume the availability of advanced technologies that may not yet be feasible or cost-effective in many public markets across Southeast Asia.

Further inconsistencies arise in interpreting the inclusion of adjacent green areas, such as shelter zones, within the green open space calculation. These ambiguities suggest the need for more precise regulatory definitions and context-responsive scoring systems. Similarly, current regulations grant high scores for land remediation but offer no credit for projects sited on uncontaminated land, potentially disincentivizing environmentally responsible site selection. Buildings without basements also automatically receive zero scores, despite the hydrological and resilience benefits of avoiding deep excavation, particularly in flood-prone areas.

In the Jongke Market case, the building is situated on land free from hazardous contamination and does not intersect with subterranean infrastructure or public facilities. Despite these advantages, it received no points for the corresponding sub-parameter, highlighting a mismatch between regulatory intent and sustainability outcomes. These issues call for a critical reassessment of PERMEN PUPR No. 21 of 2021, especially regarding high-weight sub-parameters such as Construction Above or Below Ground, Water, and Public Infrastructure.

On a more positive note, parameters such as Provision of Pedestrian Path and Outdoor Lighting System were successfully fulfilled. These reflect practices that are already well adopted in urban environments across Indonesia, suggesting that regulatory goals in these domains are achievable. Regarding Building Orientation, the design flexibility demonstrated in Jongke Market, such as optimizing façade alignment and applying complementary thermal mitigation strategies, illustrates that optimal performance can still be achieved within site constraints.

Based on these findings, several key recommendations

emerge for broader application in similar urban market settings across Indonesia and Southeast Asia:

1. Apply flexible orientation strategies to enhance thermal performance through passive design.
2. Prioritize high-performance and durable materials early in the planning process to improve heat reflectance and reduce surface temperatures.
3. Expand green open space provision by integrating adjacent vegetated zones around the market perimeter.
4. Adopt vertical or mechanical parking systems where land is constrained, allowing for more efficient land use.
5. Include EVCS infrastructure in future developments to align with emerging sustainable transportation trends.

These strategies can guide future public market planning and promote regulatory revisions that are more attuned to the typological and infrastructural realities of Southeast Asian urban environments.

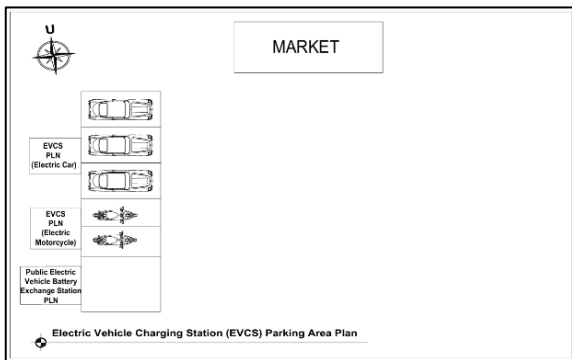


Fig. 13. EVCS parking area plan.

V. CONCLUSION

This study critically evaluated the green building performance of Jongke Market using the site management parameters outlined in PERMEN PUPR No. 21 of 2021. The results show that moderate to high compliance is achievable even in space-constrained public market environments, particularly when contextual planning and integrated passive design strategies are adopted. Key strengths included pedestrian access, vegetation coverage, and rainwater management. However, several limitations emerged, particularly related to rigid or ambiguous regulatory criteria, such as the lack of credit for clean sites, the penalization of buildings without basements, and unclear definitions in green open space assessment.

While PERMEN PUPR No. 21 of 2021 offers a robust regulatory framework, its effective implementation remains limited, especially among existing traditional markets in Indonesia. In practice, many markets have not adopted green building principles due to infrastructure constraints, lack of guidance, or funding limitations. Therefore, future revitalization policies, such as the government's directive to upgrade all markets, must mandate adherence to green building criteria with a clear implementation timeline, technical assistance, and funding mechanisms. Regulatory flexibility and typology-specific guidelines will be essential to ensure feasibility across

diverse urban and regional contexts. Critically reflecting on the regulation, it becomes evident that a one-size-fits-all approach is insufficient. The standard must evolve to accommodate the spatial and operational uniqueness of traditional markets and similar facilities. Future iterations of the regulation should adopt performance-based indicators, integrate clearer definitions, and incentivize proactive sustainability practices, such as EVCS, vertical greenery, and low-impact site selection.

For future research, a more strategic agenda is needed. Future studies should expand the assessment to all green building parameters across various building types and regions. Cross-comparative research will be essential to evaluate the effectiveness of green building criteria in different socio-spatial contexts. Additionally, empirical studies linking green performance scores with user satisfaction, thermal comfort, and operational efficiency will help refine policy and influence urban design practices. Ultimately, future assessments hold the potential to inform regulatory refinement, align national sustainability goals, and establish market typologies as legitimate contributors to urban climate resilience across Indonesia and Southeast Asia.

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