ARCHITENSA
Architecture Design Journal
ISSN Online xxxx-xxxx
Print xxxx-xxxx

OCEAN GREEN SCIENCE DISTRICT IN SURABAYA: A MARINE SCIENCE HUB WITH A FUTURISTIC APPROACH

Wahyu Kurniawan 1*,Nurhamdoko Bonifacius 2,Razqyan Mas Bimatyugra Jati 3

[1] Architecture Study Program, Faculty of Engineering, Unviersity of Merdeka Malang
[2] Final Assignment Project Advisor, Architecture Study Program, University of Merdeka Malang
[3] Final Assignment Project Advisor, Architecture Study Program, University of Merdeka
Terusan Dieng Street. 62-64, Pisang Candi, Sukun District, Malang City, East Java, 65146
**Email: wahyukurniawan.wg@gmail.com*

ABSTRACT

This architectural design project proposes the Ocean Green Science District in Surabaya, a marine research center that integrates sustainability, smart technology, and futuristic architectural expression. The selection of Surabaya's coastal area as the site reflects its strategic location in supporting national marine research, education, and innovation. The design is guided by a contextual, functional, and morphological approach, aiming to harmonize the building with the coastal environment while also responding to urban dynamics.

The main concept, "A Futuristic Harmony of Marine Science," is translated through a combination of fluid building forms, wave-inspired facades, and smart green infrastructure. The project is divided into two building masses: Aegir, the high-rise research tower that symbolizes strength and knowledge of the sea, and Ranalia, the supporting low-rise complex that embraces openness and adaptability. Together, they form a unified marine science hub connected by an eco-corridor and sky bridge system.

This project emphasizes not only environmental and technological integration, but also architectural storytelling that represents the depth and dynamism of the ocean. The result is a research facility that is visionary, functional, and responsive to the future of marine science

Keywords: *Marine Architecture; Smart Eco District; Futuristic Design; Research Facility; Surabaya*

INTRODUCTION

Indonesia, with over 17,000 islands and a marine territory of more than 6.4 million km², possesses one of the highest levels of marine biodiversity in the world, particularly within the coral triangle region (Ateng Hartanto, 2024). This wealth includes fisheries, marine energy, maritime industries, and environmental services that have the potential to serve as the backbone of the national economy. However, excessive exploitation, pollution, climate change, and the lack of infrastructure and marine technology innovation continue to hinder its optimal utilization (Bayu Trikuncoro & Ali Ridho, 2025).

The marine sector is a key driver of innovation-based economic growth. In 2023, fisheries contributed 2.66% to Indonesia's GDP (Hartanto, 2024), yet offshore oil, tidal, and current energy remain underutilized due to limited research and innovation facilities (Mariana Kristiyanti et al., 2023). This calls for an integrated marine science center that connects research, technology, and coastal community empowerment.

The Ocean Green Science District is proposed as a marine research and innovation zone focused on sustainability and coastal empowerment, aligning with the Surabaya Regional Development Plan (RPJMD 2021-2026, n.d.). This project applies the blue economy concept that emphasizes sustainable, efficient, and environmentally friendly use of marine resources through innovative technologies (Najma Alifa, 2024). The design is guided by neo-futuristic architectural principles, using dynamic forms, smart technologies, and eco-friendly materials such as GFRC to ensure resilience in coastal conditions (Gumilang & Hantono, 2023).

The site in Kenjeran District, Surabaya, was selected based on spatial suitability and development potential as outlined in the Surabaya Spatial Plan (RTRW Kota Surabaya 2014-2034, n.d.) and local policies supporting sustainable tourism and maritime-based education.

This project adopts a Public-Private Partnership (PPP) scheme for long-term sustainability and encourages synergy between research, education, commerce, and ecotourism (Khanom & Khanom, 2010). The goal is to establish a marine science center that not only advances research and innovation, but also fosters socio-economic inclusion through blue economy principles and sustainable architectural design.

LOCATION DESCRIPTION

Located in East Java, Surabaya is the second-largest city in Indonesia and functions as a major economic, maritime, and educational hub. As a coastal metropolitan city, Surabaya plays a strategic role in supporting the national marine economy, including fisheries, ports, education, and marine industries. The development of a marine research and innovation district in this region aligns with the national and regional goals for sustainable coastal development.

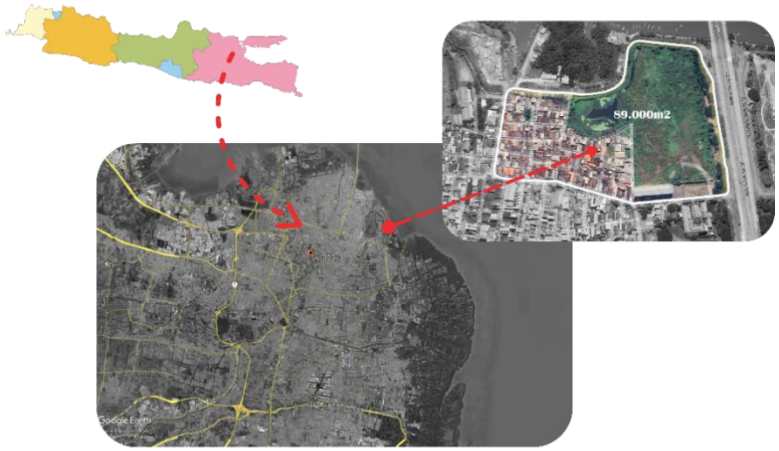

Figure 1. Selected location (Source: author)

The selected site is situated in Kenjeran District, northeastern Surabaya. According to the Surabaya Spatial Plan (RTRW 2014–2034), Kenjeran is designated as an area for coastal tourism, environmental conservation, and service-based development. Its proximity to the coast, availability of land, and existing maritime culture makeit a suitable location for the establishment of a marine science center.

Figure 2. Existing site (Source: author)

Physically, the site is accessible via arterial roads and is located near coastal tourist attractions such as Kenjeran Beach and the Surabaya North Quay. The surrounding area includes residential zones, educational facilities, and small-scale fisheries, which provide both challenges and opportunities for integration with the local socio-economic context. The site conditions such as climate, wind orientation, solar exposure, and coastal vulnerability were analyzed as key parameters in the architectural design process.

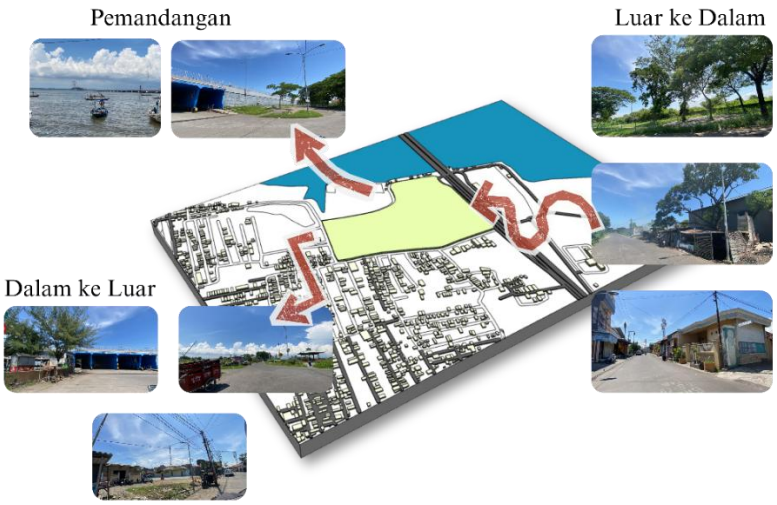

Figure 2.View site (Source: author)

By positioning the Ocean Green Science District within this macro-to-micro spatial logic, the project is expected to serve not only as a local facility but also as a regional hub that promotes sustainable marine innovation across the archipelago.

THE SITE ANALYSIS

The project site is located in Kenjeran District, Surabaya, a coastal area characterized by flat topography and direct access to the Java Sea. The area experiences a tropical monsoon climate with average temperatures ranging between 25°C and 33°C, high humidity levels, and prevailing winds predominantly from the west and east. These climatic factors influence building orientation, natural ventilation strategies, and the use of sun-shading devices.

Figure 3. site analysis (Source: author)

Solar exposure is high throughout the year, with peak sunlight intensity during the dry season from May to September. The analysis of solar path and wind direction was used to maximize passive cooling and reduce energy consumption. The coastal location also requires considerations for saltwater corrosion, flood risk, and structural resilience.

Figure 4 analysis climatologist. (Source: author)

The site is accessible through arterial roads such as Jalan Kenjeran and is connected to nearby tourist attractions including Kenjeran Beach, Sanggar Agung Temple, and the Surabaya North Quay. Public transport is available but limited, emphasizing the importance of pedestrian and bicycle-friendly infrastructure.

Socially, the surrounding area includes mixed residential communities and traditional fishermen settlements. This context presents an opportunity for social integration, community education, and inclusive economic development. The site's proximity to the ocean supports the thematic identity of the project and enhances its function as a living laboratory for marine research and innovation.

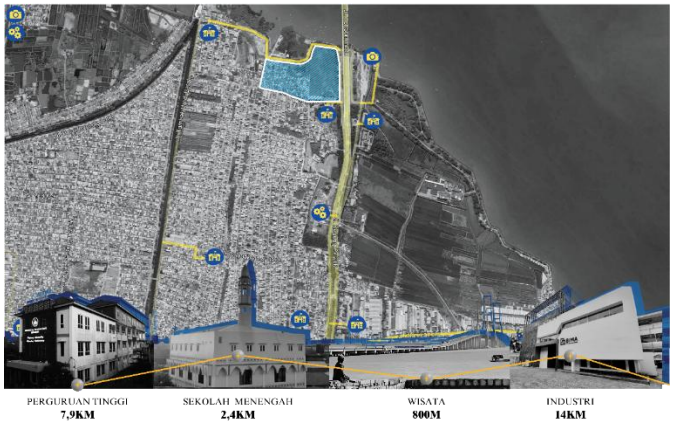

Figure 5. Environmental link (Source: author)

Overall, the site offers both challenges and advantages for sustainable coastal development, and its characteristics were integral to the formulation of architectural responses in the design process.

CONCEPTUAL APPROACH AND WARFARE THEME

The conceptual approach of the Ocean Green Science District is rooted in the integration of blue economy principles with neo-futuristic architecture. This project seeks to respond to current and future marine challenges through a visionary design that is environmentally responsible, technologically advanced, and socially inclusive.

The core idea draws inspiration from the dynamic, unpredictable nature of the ocean a space of both opportunity and struggle. This duality gives rise to a "warfare theme", not in the literal military sense, but as a metaphor for the continuous human effort to understand, preserve, and sustainably utilize the sea. The architectural language reflects this theme through organic forms, wave-like structures, and adaptive systems that embody resilience, movement, and innovation.

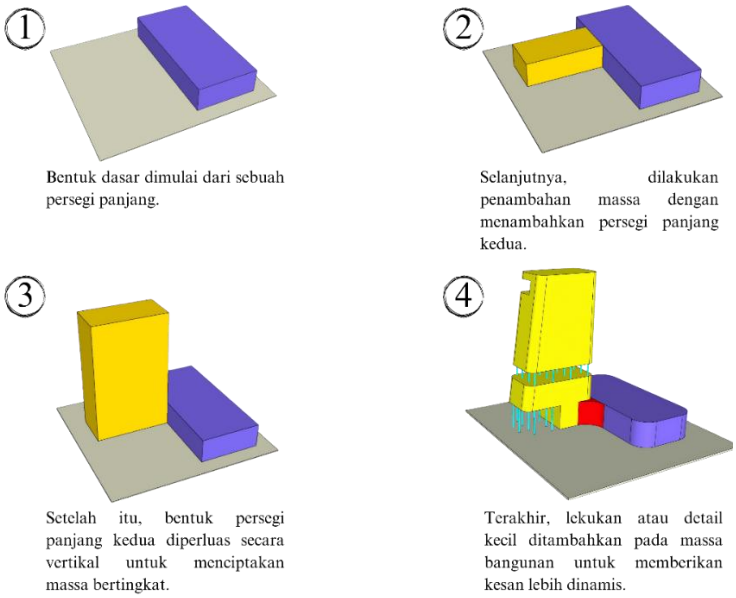

Figure 6. Shape transformation (Source: author)

Neo-futurism was chosen as the main architectural direction due to its emphasis on technology, fluidity, and ecological integration. The project incorporates renewable energy systems, smart water management, and responsive façade technologies to ensure environmental efficiency. Morphologically, the design imitates oceanic elements such as currents, marine organisms, and topographic flows, creating a space that is both futuristic and contextually sensitive.

Programmatically, the district is divided into research, educational, and commercial zones all interlinked through interactive public spaces that encourage knowledge sharing and community engagement. The design aims to function as a "living infrastructure" that evolves with the growth of marine research and innovation in Indonesia.

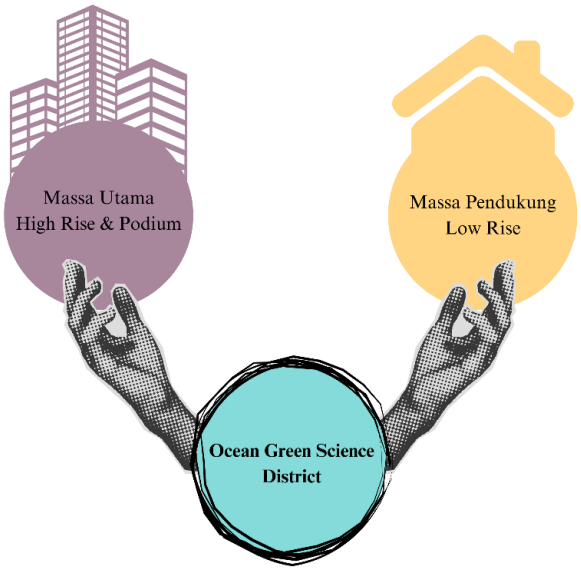

Figure 8. Massing Concept (Source: Author)

DESIGN THEME

The design theme of Ocean Green Science District is inspired by the ever-evolving character of the ocean fluid, adaptive, and interconnected. This theme is expressed architecturally through the integration of marine biomimicry, smart eco-technologies, and futuristic spatial composition. The project embodies a vision of a marine innovation ecosystem that functions not only as a research facility but also as an iconic symbol of Indonesia's maritime identity.

Architectural elements reflect wave dynamics, ocean currents, and marine organisms, resulting in forms that are organic, layered, and kinetic in appearance. This thematic approach aligns with the blue economy philosophy, where sustainability, regeneration, and community empowerment become design priorities.

Functionally, the layout encourages multidisciplinary collaboration, knowledge sharing, and public accessibility. Spaces are designed to be open, flexible, and responsive to environmental conditions. Green infrastructure, such as vegetated roofs, rainwater harvesting systems, and passive cooling strategies, reinforce the theme of ecological responsibility.

IMPLEMENTATION OF CONCEPT IN DESIGN

The Ocean Green Science District integrates the concept of the blue economy and neo-futuristic architecture through a design that emphasizes ecological responsiveness, spatial innovation, and technological adaptability. The design is implemented across multiple scales from masterplan zoning to architectural detailing ensuring that the conceptual narrative is embedded in every aspect of the project.

Figure 7. Perspective (Source: author)

The massing of the buildings reflects wave dynamics and marine topographies, creating fluid, organic forms that respond to the coastal setting. The main tower (Aegir) is designed with a dynamic facade system inspired by ocean currents and equipped with smart shading panels that adapt to sunlight intensity. The secondary building (Ranalia) features low-rise volumes integrated with landscape elements to support community interaction and environmental harmony.

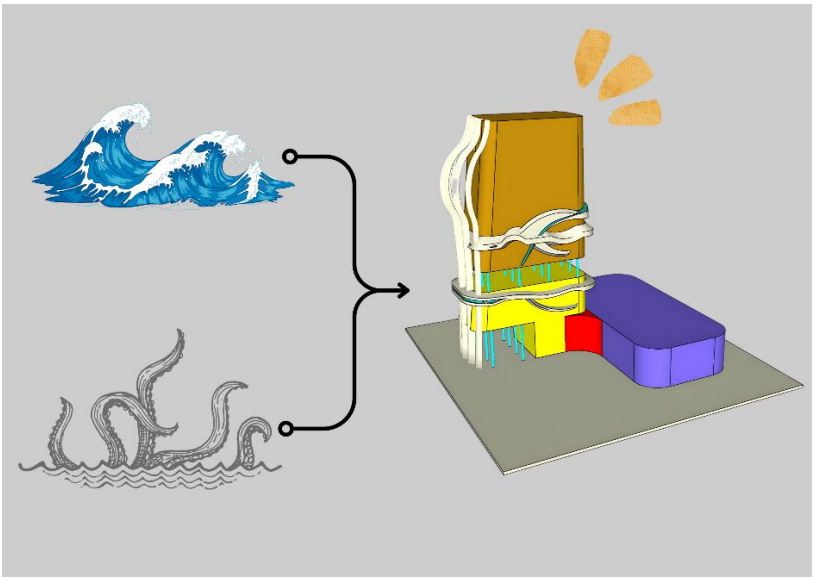

Figure 8. Facade concept (Source: author)

Figure 9. Skybridge (Source: author)

Sustainability principles are applied through the use of renewable energy sources (solar panels and wind turbines), rainwater harvesting, passive cooling strategies, and the use of materials resistant to coastal conditions, such as GFRC and weathering steel. The landscape design supports native coastal vegetation and includes bioswales for stormwater management.

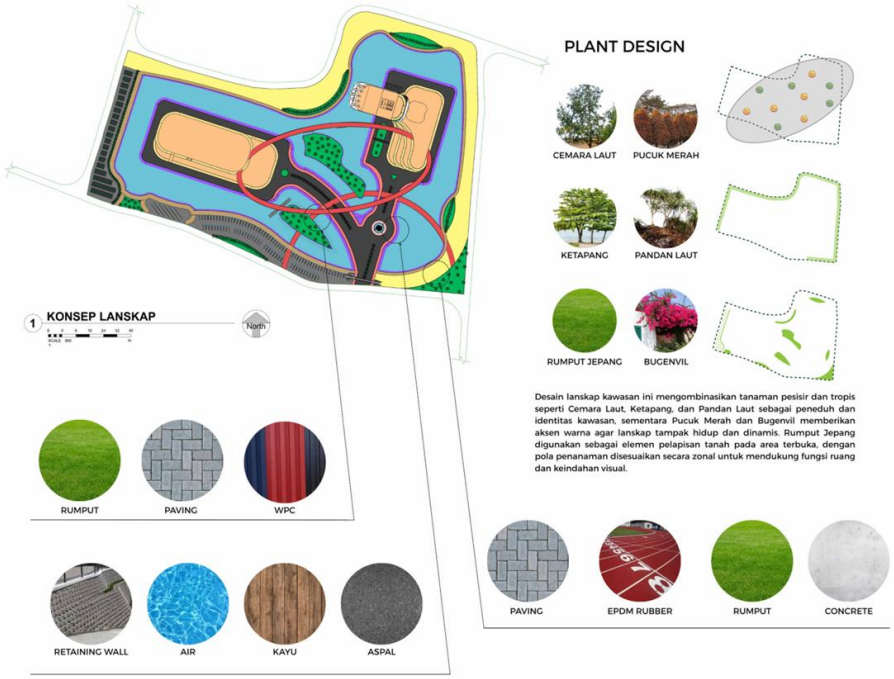

Figure 10. Vegetation concept (Source: author)

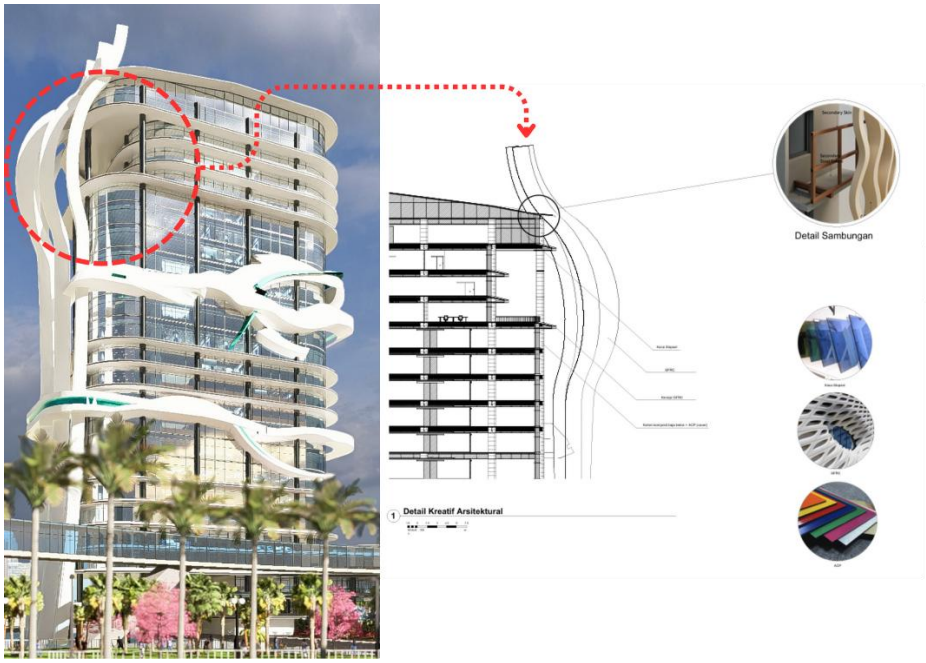

Figure 11. Implementation (Source: author)

CONCLUSION AND SUGGESTIONS

The Ocean Green Science District presents a comprehensive architectural response to the growing urgency of marine research, sustainability, and innovation in Indonesia. By integrating the principles of the blue economy and neo-futuristic architecture, the project offers a spatial solution that is not only functionally effective but also contextually and environmentally sensitive.

The design successfully translates key conceptual ideas such as adaptability, sustainability, and interdisciplinary collaboration into a built environment that supports education, research, and economic activity in the maritime sector. The combination of responsive architecture, renewable energy strategies, and ecological landscape integration ensures that the project is both visionary and grounded in real-world needs.

This project demonstrates the potential of architecture as an agent of change in addressing global challenges such as climate change, ecological degradation, and knowledge accessibility. It also underscores the importance of creating future-proof environments that prioritize collaboration, innovation, and environmental stewardship.

For future development, similar approaches could be applied to other coastal areas in Indonesia, with adjustments based on local cultural, ecological, and economic contexts. Further research is recommended to refine the technological aspects of coastal architecture, especially in relation to adaptive infrastructure and smart systems for extreme environmental conditions.

REFERENCES

Adner, R. (2006). *Match Your Innovation Strategy to Your Innovation Ecosystem*. www.hbrreprints.org

Ateng Hartanto. (2024). *statistik sumber daya laut dan pesisir* (Vol. 21).

Bayu Trikuncoro, & Ali Ridho. (2025). *The utilization of natural resources in high seas for the advancing Indonesian*. https://doi.org/10.52307/jmi.v912.177

BUKU PENELITIAN HILIRISASI. (n.d.).

Daniels, T. (2019). McHarg's theory and practice of regional ecological planning: retrospect and prospect. In *Socio-Ecological Practice Research* (Vol. 1, Issues 3–4, pp. 197–208). Springer. https://doi.org/10.1007/s42532-019-00024-4

Direktur Jendral Perhubungan darat. (n.d.).

Francisco Carrillo. (2006). *Knowledge Cities*.

Gumilang, M. R., & Hantono, D. (2023). KAJIAN KONSEP ARSITEKTUR FUTURISTIK PADA BANGUNAN MUSEUM HEYDAR ALIYEV CENTER AZERBAIJAN. *PURWARUPA Jurnal Arsitektur*, *7*(2), 101. https://doi.org/10.24853/purwarupa.7.2.15-22

ISO/IEC 27001. (n.d.). *Information technology Security techniques Information security management systems Requirements*.

Kelautan, K., & Perikanan, D. (2020). *Capaian Kinerja*.

KEMENLHK No 14 Tahun 2021. (n.d.). *PENGELOLAAN SAMPAH PADA BANK SAMPAH*. www.peraturan.go.id

Khanom, N., & Khanom, N. A. (2010). Conceptual Issues in Defining Public Private Partnerships (PPPs). In *International Review of Business Research Papers* (Vol. 6, Issue 2). https://www.researchgate.net/publication/228862464

Madanipour, A. (2003). Public and private spaces of the city. In *Public and Private Spaces of the City*. Routledge Taylor & Francis Group. https://doi.org/10.4324/9780203402856

Mariana Kristiyanti, Kundori Kundori, & Renny Hermawati. (2023). *MEMBANGUN SUMBER DAYA MANUSIA DAN TEKNOLOGI INFORMASI SEBAGAI DASAR KEJAYAAN MARITIM DI INDONESIA*.

Marlia Andriana, M. (2017). *Standar-Sarana-prasarana-Penelitian-6*.

Najma Alifa, N. (2024). *PENGEMBANGAN EKONOMI BIRU SEBAGAI STRATEGI INDONESIA MENUJU EKONOMI MAJU* (Vol. 38, Issue 1). https://e-journal.stispolwb.ac.id

Neufert Architect's Data Jilid I. (n.d.).

Neufert Architect's Data Jilid II. (n.d.).

NSI 2016. (n.d.). *Implementation timescale for existing Approved Companies*.

Pawan G. Patil, John Virdin, Sylvia Michele Diez, Julian Roberts, & Asha Singh. (2016). *Toward a Blue Economy: A Promise for Sustainable Growth in the Caribbean*. www.oceanarthub.org

PERKAP No 24 Tahun 2007. (n.d.). *SISTEM MANAJEMEN PENGAMANAN ORGANISASI, PERUSAHAAN DAN/ATAU INSTANSI/LEMBAGA PEMERINTAH*.

Permen KP No.39. (2021). *permen-kp-no.-39-tahun-2021*.

Permenkes No 492 Tahun 2010. (n.d.). *Persyaratan Kualitas Air Minum*.

PPRI No 14 Tahun 2012. (n.d.). *KEGIATAN USAHA PENYEDIAAN TENAGA LISTRIK DENGAN RAHMAT TUHAN YANG MAHA ESA PRESIDEN REPUBLIK INDONESIA*.

PPRI No 27 Tahun 2020. (n.d.). *PENGELOLAAN SAMPAH SPESIFIK*.

PPRI no.22 Tahun 2021. (n.d.). *PERATURAN PEMERINTAH REPUBLIK INDONESIA NOMOR 22 TAHUN 2021 TENTANG PENYELENGGARAAN PERLINDUNGAN DAN PENGELOLAAN LINGKUNGAN HIDUP*.

PU No 20 Tahun 2009. (n.d.). *PEDOMAN TEKNIS MANAJEMEN PROTEKSI KEBAKARAN DI PERKOTAAN*.

PU No 26 Tahun 2008. (n.d.). *PERSYARATAN TEKNIS SISTEM PROTEKSI KEBAKARAN PADA BANGUNAN GEDUNG DAN LINGKUNGAN*.

PUPR No 27 Tahun 2016. (n.d.). *PENYELENGGARAAN SISTEM PENYEDIAAN AIR MINUM*.

PUPR04-2017. (n.d.). *Pengelolaan Air Limbah Domestik*.

Rencana Pembangunan Jangka Menengah Daerah (RPJMD). (2016).

RENSTRA-DSDABM-TAHUN-2021-2026. (n.d.).

RPJMD 2021-2026. (n.d.).

RTRW Kota Surabaya 2014-2034. (n.d.).

Sassi, Paola. (2006). *Strategies for sustainable architecture*. Taylor & Francis.

SNI 03-1733-2004. (n.d.). *Tata cara perencanaan lingkungan perumahan di perkotaan Badan Standardisasi Nasional*.

SNI 2398:2017. (n.d.). *Tata cara perencanaan tangki septik dengan pengolahan lanjutan (sumur resapan, bidang resapan, up flow filter, kolam sanita)*. www.bsn.go.id

SNI 6773:2008. (n.d.). *Standar Nasional Indonesia Spesifikasi unit paket instalasi pengolahan air*.

UU Nomor 30 Tahun 2009. (n.d.). *KETENAGALISTRIKAN*.

Zulfa Khoiriyah, A. (2024). *IMPLEMENTASI EKONOMI BIRU DI INDONESIA*. *8*(2).