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Riparian Landscape Design with the Riverwalk Concept for the Revitalization of the Deli River in Medan City

Liza Arryani Khairunisa[1], Sri Shindi Indira[2*], Fariz Harindra Syam[3]
Universitas Pembangunan Panca Budi
Corresponding Author: Sri Shindi Indira shindi.indira@pancabudi.ac.id

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A B S T R A C T

The Deli River in Medan City serves as a vital ecosystem and water source but faces pollution and poorly managed riverbanks. To address these issues, a Riverwalk-based riparian landscape design is proposed to restore ecological functions while providing aesthetic and functional green space. The design integrates ecological approaches, functional zoning, and green infrastructure like rain gardens and bioswales to manage stormwater and protect the river. Key features include jogging tracks, bicycle paths, playgrounds, vendor areas, and educational spaces. This concept aims to enhance the riverbank's appeal, promote community engagement, and support environmental sustainability in Medan City.

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INTRODUCTION

The Deli River in Medan City is one of the essential elements of the urban ecosystem, playing ecological, social, and economic roles. As a water source and natural habitat, the Deli River has the potential to be developed into a green open space that supports various community activities. However, the current condition of the Deli Riverbanks faces several challenges, including water pollution caused by domestic waste disposal, ecosystem degradation, and a lack of accessibility and proper management. This situation has resulted in the riparian area being underutilized by the community. A riparian design that aligns with environmental conditions also holds social value, serving as a space for recreation, education, and aesthetics/beauty (Oktavianus, 2022).

The Riverwalk concept has proven to be an effective approach in addressing various riverbank issues, as demonstrated in studies by Sutrisno (2011), Adrian & Santoni (2020), Aji (2018), Arif (2024), and Evta et al. (2021). In these studies, the implementation of a Riverwalk in the Flamboyan Bawah area of Palangka Raya City successfully created a public open space that not only improved environmental quality but also served as an attractive social interaction area for the community. Furthermore, Adzkia and Fatimah (2020) highlighted that a landscape design based on community preferences along the Cipinang River in East Jakarta resulted in an inclusive and functional public space through zoning arrangements that considered local needs, such as pedestrian pathways, green areas, and recreational facilities.

Furthermore, Subianto et al. (2019) proposed the Eco-Riverwalk village concept for the East Flood Canal River area in Semarang City. This concept integrates environmentally friendly design with social facilities, such as recreational parks, green corridors, and sustainable waste management. The study demonstrated that well-managed riverbank areas can enhance environmental quality while supporting social and ecological sustainability, as also highlighted in research by Herri et al. (2022), Hertiari (2018), Husni (2017), Irda (2021), Nurini (2015), Rini (2024), and Titin (2022).

Unlike previous designs, the Riverwalk-based landscape design for the Deli Riverbanks in Medan City not only adopts ecological and social approaches but also integrates environmental education to raise public awareness about the importance of river conservation. Additionally, this design emphasizes the implementation of green infrastructure, such as bioswales and rain gardens, to manage stormwater runoff and prevent further pollution. The proposed zoning includes jogging tracks, bicycle paths, playgrounds, vendor areas, and aesthetically designed connecting bridges to enhance visual appeal, as suggested by Wakhidah et al. (2022) and Nuraini & Ndruru (2024).

A key distinguishing element of this design is its focus on comfort and user experience for people of all age groups. This concept functions not only as an environmentally friendly public open space but also as a social hub that revitalizes the Deli Riverbanks into a sustainable space for interaction and recreation. Thus, this design is expected to address the specific challenges of the Deli River area while offering added value not present in previous designs.

THEORETICAL REVIEW

The riparian area serves as a transitional zone between the river and the land. It can exist in a natural state or be designed for purposes such as soil stabilization or land revitalization (Triwanto, 2024; FH Syam dkk, 2023). The Riverwalk concept has been widely implemented as a solution for riparian river development, creating environmentally friendly interaction spaces. Sutrisno (2011) explains that a Riverwalk can function as an open space that supports social activities, enhances visual appeal, and improves environmental quality in riverfront areas.

Emphasizing community preferences in riverbank landscape design, as highlighted by Adzkia and Fatimah (2020), Nuraini (2019, and Nuraini (2024), is a crucial element to ensure that the created spaces meet user needs while remaining functional. Additionally, Subianto et al. (2019) introduced the eco-Riverwalk concept, which integrates green infrastructure such as bioswales and rain gardens to improve stormwater runoff management and protect river ecosystems (FH Syam dkk, 2024).

The Deli River in Medan City plays a vital role as an ecosystem element and water resource, yet this area faces significant challenges, including pollution and environmental degradation caused by human activities (Fitri, 2018; FH Syam, 2023;). Proper management of the Deli River through a Riverwalk-based design approach is expected to address pollution issues, provide a comfortable public space, and raise community awareness about the importance of environmental conservation. By implementing zoning that includes green corridors, recreational facilities, and educational areas, this design has the potential to transform the Deli Riverbanks into a functional, aesthetically pleasing, and sustainable urban space.

METHODOLOGY

The Riparian Landscape Design Method with the Riverwalk Concept for the Revitalization of the Deli River in Medan City employs a systematic and structured approach. This method is designed to produce a design solution that is not only aesthetically pleasing but also sustainable and functional, referencing various literature studies and previous design practices. This approach integrates site analysis, user needs, and the application of relevant ecological and social concepts. The process consists of the following stages:

Data Collection Stage

Primary and secondary data are gathered through field surveys, interviews with local communities, and literature reviews. A study by Nuraini and Sudrajat (2010) on architectural design methods emphasizes the importance of understanding site context, including geographical conditions, environmental factors, and user needs, to produce a design that is relevant and suitable for local requirements. Additionally, community behavior surveys regarding the use of riverbank areas serve as the basis for determining spatial programs and facilities (Indira et al., 2023a; Indira et al., 2023b).

Site Analysis and Problem Identification

This stage involves an analysis of the existing conditions of the Deli River, including topography, land use, water quality, and environmental conditions. As part of this process, an ecological approach is used to identify key issues such as water pollution, riverbank erosion, and the lack of green spaces. Design approaches similar to those used in coworking spaces with tropical architecture principles (Mujahidin, Nuraini, & Iskandar, 2022; Nuraini, 2015) and green architecture (Pane, Nuraini, & Syam, 2022) are applied to ensure the sustainability of the design.

Design Concept Development

The primary concept applied is the integration of ecology, recreation, and education. The zoning design includes green spaces, pedestrian pathways (jogging tracks and bicycle lanes), children's play areas, and commercial facilities such as local vendor stalls. Research by Sahara, Nuraini, and Syam (2023), as well as Indira et al. (2023b), highlights the importance of integrating recreational elements with aesthetics and public space functionality, which is also implemented in this design.

Additionally, green infrastructure such as bioswales and rain gardens is designed to manage stormwater runoff and maintain river water quality. This method refers to sustainable architectural design approaches, as described by Nuraini and Thamrin (2018); FH Syam dkk (2019).

Design Simulation and Adjustments

This stage involves simulating the design using software and modeling tools to test zoning efficiency and spatial organization. The application of this design concept follows the study conducted by Munthe, Nuraini, and Wisdianti (2023), where design flexibility is considered crucial to accommodate the diverse needs of users.

Concept Implementation

Implementation is carried out by developing interconnected zones, ensuring sustainability, and enhancing the aesthetic value of the area. A community-based approach, similar to that used in shared workspace designs with a green approach (Pane, Nuraini, & Syam, 2022), is applied to encourage community participation in maintaining and utilizing the facilities.

This design methodology integrates ecological, social, and aesthetic principles while considering local needs. This approach results in a Riverwalk-based landscape design that not only improves environmental quality but also creates an inclusive and sustainable public space. The final design is expected to enhance the quality of the Deli Riverbanks while serving as a model for river landscape designs that are adaptive to environmental and social changes.

RESULTS

The Deli Riverbanks serve as both a residential area and a social space, where daily household activities such as bathing, washing, and sanitation (MCK) take place. Additionally, the riverbanks are often used as a waste

disposal site, contributing to high levels of river pollution. The primary cause of this pollution is untreated household waste, which accumulates in and around the river, creating environmental and health hazards.

The accumulation of waste along the river significantly reduces biodiversity, particularly affecting the fish habitat, which has been declining due to poor water quality. Furthermore, the polluted water poses a serious health risk to the surrounding community, especially those who rely on the river for their daily activities. The Deli River, located in Medan City, is surrounded by residential settlements, as illustrated in Figure 1.

Figure 1. Location of the Deli River in Medan City
(Source: Google Earth, 2025)

The eastern area of the Deli River is bordered by residential neighborhoods, office buildings, commercial establishments, and other public service facilities. Similarly, the western area of the Deli River is also adjacent to residential neighborhoods, office buildings, commercial establishments, and public service facilities. This can be observed in Figure 2, where the area is actively utilized by the surrounding community.

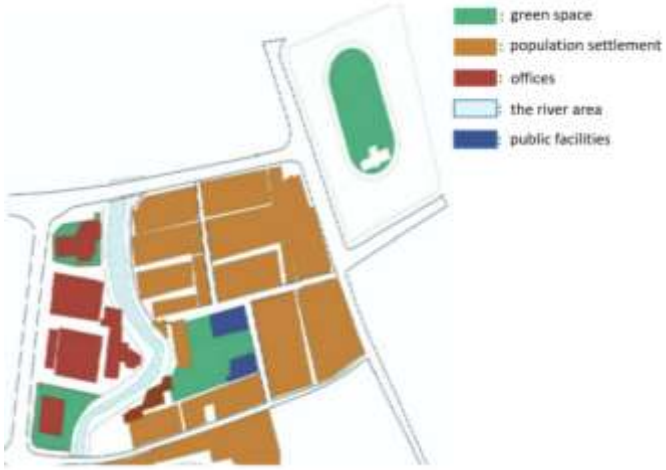

Figure 2. Area Along the Deli River in Medan City
(Source: Author, 2025)

The high level of activity around the Deli River has impacted its existing condition, which remains largely unplanned due to the lack of proper landscape element arrangements. As a result, the area is less attractive to visitors. The environment appears cluttered due to the absence of organized spatial planning, as the area primarily consists of residential settlements. Additionally, the frequent activities in this area have led to improper

treatment of the river, such as indiscriminate waste disposal. Plastic waste, which is particularly difficult to decompose, is commonly found along the riverbanks.

Site Analysis

The site analysis includes Existing Condition Analysis, Climate Analysis, Site Analysis, and Noise Analysis. The Existing Condition Analysis reveals that the presence of abundant weeds and tall wild grass along the banks of the Suga River is one of the factors contributing to the ease with which people dispose of waste in this area. The accumulated waste and overgrown vegetation in the Deli River lead to various issues, such as river flow obstruction, increased mosquito larvae growth, and water pollution due to waste contamination. In Figure 3, the existing conditions show a lack of attention in terms of spatial arrangement and landscape design.

Figure 3. Existing Conditions of the Deli River in Medan City
(Source: Author, 2025)

The Site Analysis of the Deli River includes an assessment of the existing environmental conditions, such as site area, river width, and river length. The total area to be designed is approximately 2.14 hectares, with a river length of around 450 meters and a width ranging between 10 to 18 meters. The site analysis of the Deli River is illustrated in Figure 4.

Figure 4. Site Analysis
(Source: Author, 2025)

Through the site analysis, it is determined that the designed area consists of riverbanks with a width of 15 meters from the river's edge. This

measurement complies with Regulation of the Minister of Public Works and Public Housing (PUPR) of the Republic of Indonesia No. 28 of 2015 regarding the Determination of Riverbank and Lake Shore Boundaries, which states that urban riverbanks must have a width of 10-15 meters (PUPR No. 28, 2015).

The environmental conditions of the Deli River, based on site surveys, are as follows:

a. Eastern area of the Deli River is bordered by residential areas, offices, commercial buildings, and public service facilities.
b. Western area of the Deli River is also bordered by residential areas, offices, commercial buildings, and public service facilities.
c. The riverbanks have a significant number of trees, contributing to green space. The most common trees found along the Deli River include bamboo, trembesi trees, and several other shade trees.
d. There is no designated green open space in the site area for public gatherings. Residents typically gather along the riverbanks or in front of their homes. However, most areas along the Deli River are overgrown with uncontrolled vegetation and wild grass, creating an unorganized and unkempt appearance.

The climatic conditions of the Deli River area indicate that sunlight penetrates the site throughout the day. The positive aspect of sunlight is its natural illumination, particularly during the daytime, which contributes to energy savings. However, the negative aspect is heat radiation and glare. The buildings surrounding the site are generally mid-rise structures with an average height of three stories, suggesting that sunlight enters the site consistently throughout the day. This condition is illustrated in Figure 5.

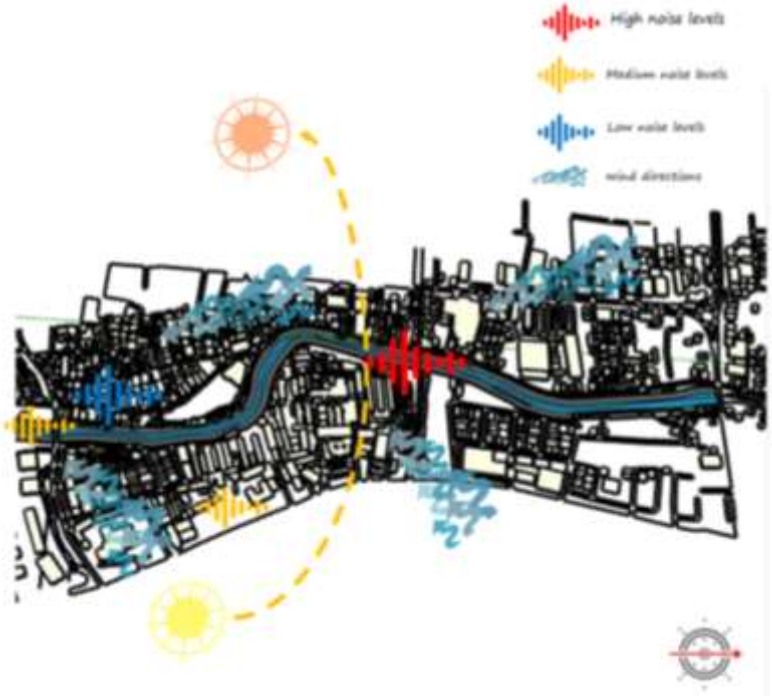

Figure 5. Climate, Wind Direction, and Noise Analysis
(Source: Author, 2025)

As Indonesia is located in a tropical climate, sunlight intensity needs to be regulated to ensure thermal comfort for users. The wind at the site generally comes from the south, known as mountain wind, and from the east, influenced by the eastern monsoon wind, which tends to blow at a moderate speed. The trees around the site are typical urban vegetation and do not significantly obstruct the area, allowing wind to flow through the site throughout the day, providing natural cooling circulation along the banks of the Deli River.

Riparian Concept for the Revitalization of the Deli River in Medan

Based on the analysis, revitalization efforts should be function-based, ensuring that the Deli River area is well-planned and designed. The landscape design of the river will adopt the Riverwalk concept, serving the following functions:

1. Accessibility and Urban Connectivity: a) The area should be easily accessible for pedestrians, cyclists, motor vehicle users, and individuals with disabilities (elderly and disabled persons); and b) The circulation pattern should enhance orientation and provide multiple movement options within the area.
2. Comfort and Spatial Identity
   The design should offer comfort and aesthetic appeal for users of all age groups and backgrounds, creating a positive perception of the space.
3. Functionality and Activities: a) The riverfront should act as a magnet that attracts people to visit and engage in various public activities; b) Key success indicators include: Enjoyment (excitement); Vitality (liveliness), Attractiveness, Functionality and usability, Uniqueness and diversity, Social interactions
4. Social Interaction: The revitalized area should function as a public space where people from different social classes and backgrounds, including locals and visitors, can gather and interact.

Concept Analysis for Design Development

To achieve these functions, it is essential to first determine the design concept through a concept analysis. This involves: Developing an initial design idea, Zoning determination, User classification, Space programming. Figure 6 presents the framework of ideas for establishing the design concept for the Deli River revitalization in Medan City.

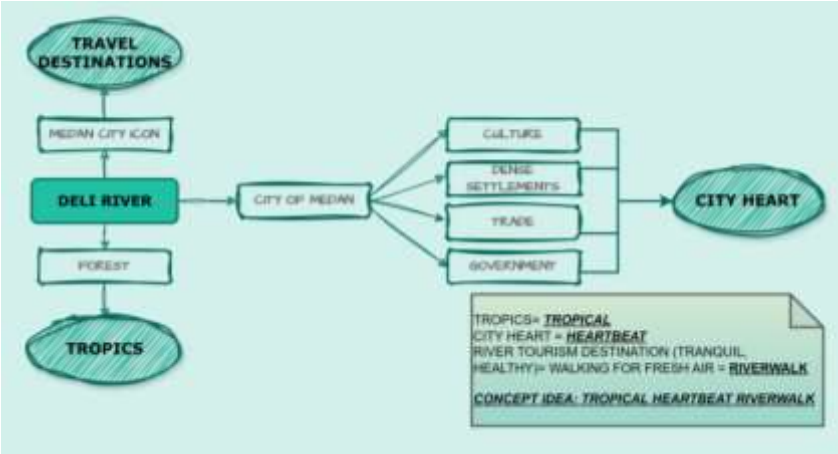

Figure 6. Conceptual Design Plan for the Deli River in Medan City
(Source: Author, 2025)

Based on the conceptual development, the Deli River design will adopt the "Tropical Heartbeat Riverwalk" theme. This concept envisions a pedestrian-friendly riverside environment that serves as a space for exercise, relaxation, and enjoying the river's natural setting in the heart of the city, while embracing tropical characteristics.

With this design concept in place, it is necessary to organize functional spaces and zoning along the Deli Riverfront to support the planned design. The spatial requirements for the Deli Riverfront in Medan City are illustrated in Figure 7.

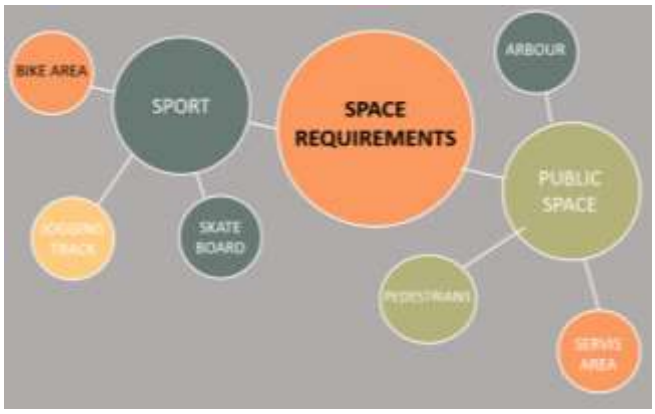

Figure 7. Spatial Requirements for the Deli River Design in Medan City
(Source: Author, 2025)

The spatial requirements have been categorized based on user classification to determine the types of activities that will be accommodated in the design plan. This classification is structured according to different user groups, which are further divided based on the activities that will take place within the area. User Classification, namely:

a) Visitor/Guest Group. Activities for this group include: Recreational Activities; Commercial Activities; Sports Activities
b) Service Group. Responsibilities of this group include: Security and maintenance of the Green Open Space (RTH); Monitoring and inspecting available facilities

After defining the spatial requirements, it is necessary to estimate the minimum space requirements for each designated area. The assumed land area for the design can be seen in table 1, which presents the space program analysis.

Table 1. Space Program

No	Name of Space	Space Requirements
1.	Recreational Facilities Space Allocation	Assumed Users: 100 people Calculation: o 100 visitors × 9 m²/person = 900 m² o Circulation: 40% × 900 m² = 360 m² o Total Area: 1,260 m²
2.	Children's Playground	Assumed Users: 20 people Calculation: o 20 visitors × 4 m²/person = 80 m² o Circulation: 40% × 80 m² = 32 m² o Total Area: 112 m²
3.	Jogging Track	Assumed Users: 15 people Calculation: o 15 visitors × 30 m²/person = 450 m² o Circulation: 40% × 450 m² = 180 m² o Total Area: 630 m²
4.	Parking Area	**Car Parking** Capacity: 50 units Calculation: o (1.5 m × 3 m) × 50 units = 225 m² o Circulation: 45% × 225 m² = 101.25 m² o Total Car Parking Area: 326.25 m² **Motorcycle Parking** Capacity: 100 units Calculation: o (1 m × 2.2 m) × 100 units = 220 m² o Circulation: 45% × 220 m² = 99 m² o Total Motorcycle Parking Area: 319 m² Total Parking Area: 645.25 m²

(Source: Author, 2025)

By incorporating extensive green spaces, creating designated waste disposal areas, installing water treatment facilities, and implementing educational signage on the importance of river conservation, these improvements will not only enhance the aesthetic appeal of the riverfront but also contribute to sustainability, air quality, and public health. Additionally, these efforts can support and improve local micro, small, and medium enterprises (MSMEs) around the Deli Riverfront in Medan City.

Design Concept

Based on the data and analysis obtained, the implementation of a concept is necessary to support the design process of the Deli River riparian landscape. The concept includes: Zoning Concept, Circulation Concept, Vegetation Concept, Water Management Concept

The zoning concept defines the designated areas for visitor activities, ensuring functional and well-organized spaces. This zoning plan can be seen in Figure 8.

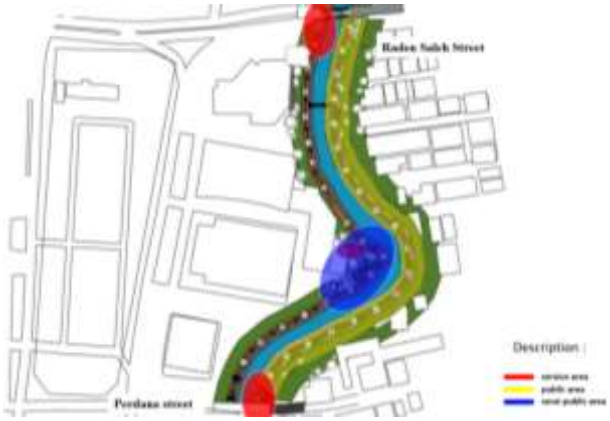

Figure 8. Zoning Concept for the Deli River Design in Medan City
(Source: Author, 2025)

The Zoning Concept for the Deli River Design in Medan City consists of three main zones:

1. Public Zone
   This area is easily accessible to all visitors. It includes: Pedestrian walkways, Jogging track, Tenant stalls and Main circulation path
2. Semi-Public Zone
   A designated area for visitors engaging in specific activities. It includes: Skateboarding area, Outdoor gym, Musholla (prayer area), Children's playground
3. Service or Private Zone
   A restricted area designated for essential services. It includes: Sanitation facilities (MCK/Toilets), Waste management area

In addition to zoning, a circulation concept is also required to ensure a smooth and organized flow of movement throughout the site. The circulation concept is illustrated in Figure 9.

Figure 9. Circulation Concept for the Deli River Design in Medan City
(Source: Author, 2025)

The circulation concept for the Deli River landscape area consists of vehicular routes and parking areas, which are positioned along the riverbank setback area that has been designed.

1. Access Points:
    a. Entrance: Located at Jalan Raden Saleh
    b. Exit: Located at Jalan Perdana
2. Pedestrian and Jogging Circulation:
    a. The pedestrian pathways and jogging track extend along the entire riverbank setback area.
    b. The area is also equipped with guiding blocks, ensuring accessibility for visitors with disabilities.

To enhance the natural beauty of the landscape design, the selection of plants should focus on species that thrive in tropical environments. These plants should aid in water absorption while also improving the aesthetic appeal of the Deli River landscape. The types of plants planned for the Deli River landscape are illustrated in Figure 10.

Figure 10. Vegetation Concept for the Deli River Design in Medan City
(Source: Author, 2025)

The vegetation used in the Deli River landscape consists of plants that are easy to grow and environmentally friendly, avoiding species that could

potentially damage the ecosystem. The following plants are chosen for their aesthetic appeal, functional benefits, and suitability for tropical environments: a) Ornamental Palms: Palem Putri (Veitchia merillii) and Palem Ekor Ikan (Caryota mitis); b) Flowering and Decorative Plants: Pisang-pisangan (Heliconia psittacorum); Bonsai Cemara (Casuarinaceae); Flamboyan (Genus Delonix), Amaryllis (Amaryllis sp.), Mini Kucai (Ophiopogon japonicus), Several types of Aglaonema (Aglaonema sp.), Pucuk Merah (Syzygium myrtifolium); c) Ground Cover and Shade Trees: Sikas (Cycas rumphi); Mini Elephant Grass (Axonopus compressus); Ketapang Kencana (Terminalia mantaly); Bungur (Lagerstroemia speciosa) and Other supporting vegetation.

Vegetation Functions: a) Plants are strategically placed to act as natural air purifiers, filtering pollutants from the surrounding environment; b) The greenery enhances the landscape aesthetics, creating a visually appealing and environmentally sustainable riverfront. Plant Maintenance: to ensure healthy growth and longevity, regular maintenance is required, including: Pruning, Fertilization, Cleaning, Periodic watering Watering is sourced from the river and recharge wells, ensuring efficient water management. The water management concept is illustrated in Figure 11.

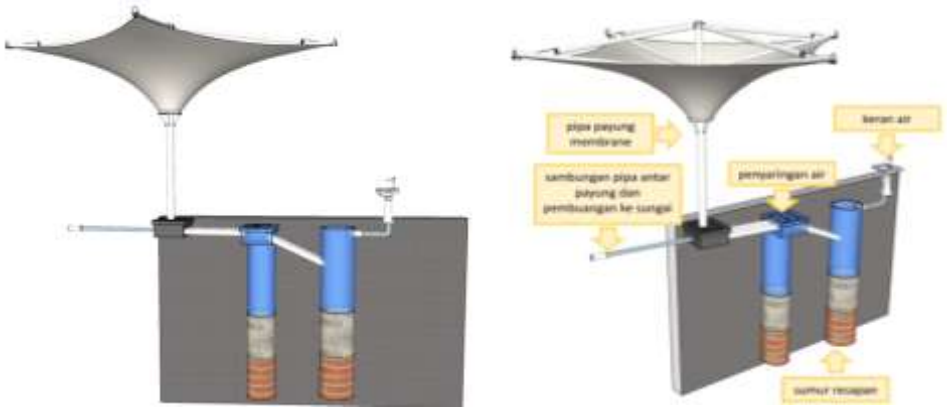

Figure 11. Rainwater Management Concept for the Deli River Design in Medan City

(Source: Author, 2025)

The rainwater management concept incorporates umbrella-shaped membrane canopies that function as rainwater collectors. The collected water is channeled through pipes into a filtration reservoir, where it is stored as a reserve for recharge wells.

Functions of the Rainwater Management System:

1. Water Collection & Utilization:
    a. Rainwater is captured by the umbrella-shaped canopies.
    b. Water flows through pipes into filtration reservoirs.
    c. Filtered water is stored in recharge wells as a water reserve.
    d. Some of the stored water is used for public sink facilities (washbasins).
    e. Excess rainwater is redirected to the river, preventing overflow in recharge wells.
2. Shading & Aesthetic Enhancement:
    a. The umbrellas provide shade for pedestrians, enhancing comfort.

b. With dimensions of 3x3 meters, the canopies effectively provide shade along the Deli River landscape.
c. The unique design adds to the visual appeal of the riverfront.

This integrated rainwater management system not only supports sustainable water use but also enhances thermal comfort and aesthetics in the Deli River landscape.

Design Outcome

Based on the data collection, analysis, and conceptual framework, the design process for the Deli River site has been developed. The Tropical Heartbeat Riverwalk concept is applied as an urban green open space, providing a pedestrian-friendly environment in the heart of Medan City. Figure 12 presents the Site Plan for the Riverwalk Landscape Design, illustrating the revitalization strategy for the Deli River in Medan City.

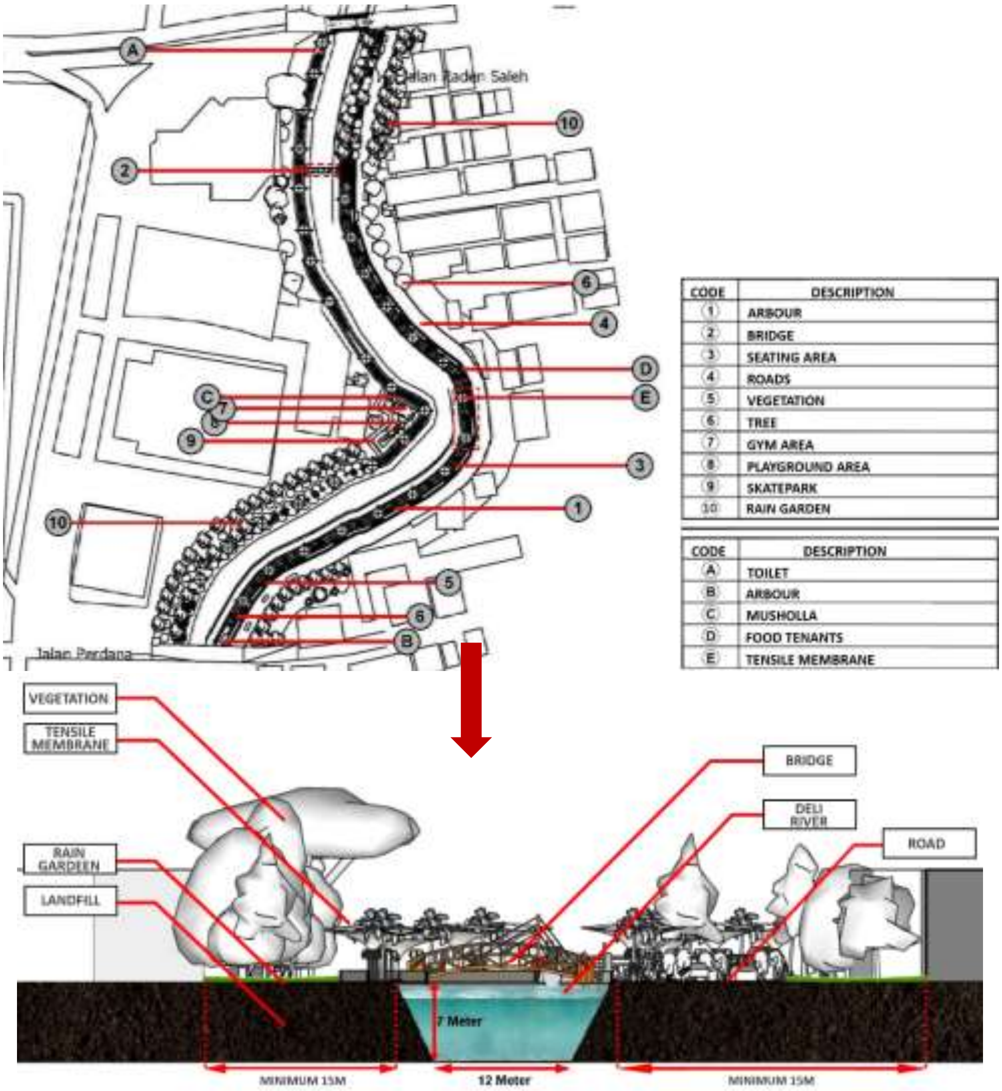

Figure 12. Site Plan of the Deli River Landscape Design in Medan City
(Source: Author, 2025)

The Deli River landscape design includes various facilities to enhance functionality, aesthetics, and user experience. The key features of the Tropical Heartbeat Riverwalk concept are: Key Facilities: 1) Pergolas – Provide shade

and add aesthetic variation to the landscape; 2) Bridges – Serve as connectors between the two riverbanks for improved accessibility; 3) Seating Areas – Offer spaces for visitors to sit and rest while enjoying the riverfront; 4) Outdoor Gym Area – Provides fitness facilities for recreational activities; 5) Playground – Designed as a safe play area for children; 6) Skate Park – Dedicated sports zone for skateboard enthusiasts; 7) Public Facilities: a) Toilets for visitor convenience; b) Service Rooms for waste management and storage of park maintenance tools; c) Musholla – A prayer facility for Muslim visitors; 8) Food Tenants – Supports local MSMEs by providing commercial spaces for vendors; 9) Membrane Canopy Structures – Multi-functional canopies that provide shade and integrate a rainwater management system. There is also a rain garden area that serves as a water absorption site during the rainy season and as a natural habitat for wildlife.

With the site plan finalized, the visual representation of the designed landscape is developed. In Figure 13, the riparian landscape design of the Deli River is presented, showcasing the layout of the Riverwalk designed for pedestrians.

Figure 13 provides a perspective view of the Deli River Landscape Design in Medan City, illustrating the pedestrian flow and overall Riverwalk concept.

The presence of a rain garden in the riparian area allows rainwater to be easily absorbed into the ground. Additionally, there are designated tenant spaces for MSMEs around the river area. In Figure 14, various facilities can be seen, including a sink, seating areas for resting, and a pergola that enhances the aesthetic variation of the design while providing shade for visitors. Additionally, an informational board about the history of the Deli River is available to enrich visitors' knowledge.

Figure 14 provides a perspective view of the Deli River Landscape Design in Medan City, highlighting the pedestrian pathways, seating areas, and umbrella canopies that enhance both functionality and aesthetics.

In Figure 15, the design showcases additional facilities, including: a) Sports Facilities: An outdoor gym area equipped with various exercise equipment to promote health and wellness among visitors; b) Children's Play Area: A dedicated playground featuring safe and engaging play structures for children; c) Musholla: A prayer facility to accommodate the religious needs of Muslim visitors; d) A rain garden area, all integrated into the landscape design of the Deli River in Medan City. These features are thoughtfully integrated into the landscape to provide a comprehensive and inclusive recreational environment along the Deli River in Medan City.

Figure 15. View 2 of the Deli River Landscape Design in Medan City
(Source: Author, 2025)

CONCLUSIONS AND RECOMMENDATIONS

The Riparian Landscape Design with the Riverwalk Concept for the Revitalization of the Deli River in Medan City holds great potential for addressing the environmental, social, and economic challenges currently faced by the area. Through an approach that integrates ecological, recreational, and educational functions, this design not only aims to restore the environmental quality of the Deli River but also to create an inclusive, aesthetic, and sustainable public space. The Riverwalk concept enables the incorporation of green infrastructure, such as bioswales derived from membrane canopies and rain gardens, to manage pollution and stormwater runoff while enhancing the visual appeal of the area. The designed zones include pedestrian pathways, recreational areas, commercial facilities, and environmental education spaces, encouraging the community to optimally utilize the riverfront area.

For successful implementation and sustainable management of this design, collaboration among the government, local communities, and private sectors is essential. Community education on the importance of preserving the river ecosystem should be an integral part of this program to build awareness and active participation. Additionally, the design development should consider flexibility to accommodate future changes in community needs and environmental conditions. With adequate support, the Deli River waterfront can become a city icon that is not only visually appealing but also serves as a solution to environmental and social issues in Medan City.

FURTHER STUDY

Future research should explore the long-term environmental impact of the Riverwalk-based landscape design, particularly its effectiveness in pollution control, stormwater management, and biodiversity restoration. Studies on the social and economic benefits, such as increased community engagement, tourism potential, and local business growth, would provide insights into sustainable urban planning. Additionally, further analysis of governance models and public-private partnerships can help ensure effective implementation and long-term maintenance. Research on adaptive design strategies to accommodate climate change and evolving community needs will also be crucial in sustaining the functionality and resilience of the Deli River waterfront.

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