G-Tech : Jurnal Teknologi Terapan
Vol. 9, No. 3, July 2025, p. 1681-1693
E-ISSN: 2623-064X | P-ISSN: 2580-8737

Railway Corridor Planning Criteria using Eco Railway Corridor Approach (Case Study: Ngaglik Street Surabaya)

Diyah Ayu Saputri[1]✉

[1] Architecture, Faculty of Sains and Technology, Universitas Bhinneka PGRI, Indonesia

✉ **Corresponding Author :** Diyah Ayu Saputri (e-mail: diyahwess@gmail.com)

Article Information

Article History

Received : June 20, 2025
Revised : July 15, 2025
Published : July 26, 2025

***Keywords*:**

Railway Corridor;
Ecology;
Planning.

ABSTRACT

Railway buffer zones along Jalan Ngaglik, Surabaya have been converted into residential settlements, creating safety risks and disrupting train operations. This land-use change violates the original function of these areas as railway support zones. This study aims to identify causes of land-use changes along Ngaglik railway corridor and formulate design criteria for restoring buffer zone function as a green corridor supporting railway activities. The research uses qualitative descriptive methodology with post-positivism paradigm. Urban design methodology follows four stages: analysis, synthesis, appraisal, and decision-making to develop comprehensive design solutions. The "Eco Railway Corridor" concept transforms the area into active public spaces using eco-friendly design elements. Key features include locally-sourced vegetation for carbon absorption, granite retaining walls with railway-inspired patterns, energy-efficient LED lighting systems, and accessible infrastructure with ramps and stairs. The design addresses existing problems by restoring railway-edge areas as safe public spaces while maintaining environmental balance. The eco-friendly approach enhances area identity and provides functional benefits for residents. This planning creates harmonious integration between railway infrastructure and surrounding community needs, ensuring operational safety while offering aesthetic and recreational value for local residents.

INTRODUCTION

Urban design is the arrangement of the physical elements of the urban environment in such a way that they function properly, are economically feasible to develop, and provide both visual and residential comfort (Tay et al, 2024). The aim is to make cities more human-centered, to connect the physical form of the city with natural conditions, to harmonize the city with nature, and to create high-quality urban spaces. Good design can be achieved by addressing issues within the urban environment while taking into account both physical and non-physical aspects of the surrounding area. Through proper planning or problem-solving efforts, an environment can be created that functions well, offers comfort, and leaves a positive impression on its users (Harms et al, 2024).

Surabaya is located in East Java Province and is the second-largest city in Indonesia, as well as the capital of East Java. Like other major cities, Surabaya has experienced significant urban development. Genteng and Simokerto Districts are part of Central Surabaya, which serves as a center of economic growth. Surrounding this area are several facilities that support community activities, including SMA 5 Surabaya, the Heroes Cemetery (Taman Makam Pahlawan), Hi-Tech

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Mall, the People's Amusement Park (Taman Hiburan Rakyat), Mundu Park, Gelora 10 November Stadium, and Kaza City. The presence of these facilities has contributed to economic development in this part of Central Surabaya. This growth includes the development of residential settlements along the railway corridor of Jalan Ngaglik, Surabaya an area that was originally intended to function as a buffer zone to support railway activities.

One of the urban spaces that requires spatial arrangement or intervention is the railway edge area that has undergone a change of function along the railway corridor of Jalan Ngaglik, Surabaya. This area presents significant urban issues that need to be addressed. The land adjacent to the railway, which was originally intended to function as a buffer zone for railway activities, has been converted into both permanent and non-permanent residential settlements. The presence of local residents engaging in activities near the railway tracks poses a serious safety risk. This condition endangers the inhabitants of these informal settlements and disrupts railway operations. Moreover, it gives rise to various problems in the railway corridor, such as improper land use, as well as issues related to safety and comfort for users (Du et al, 2023).

The study area faces issues related to the conversion of land use along the railway corridor, where the space has been utilized for both permanent and non-permanent structures, disrupting railway operations. However, the site also holds potential due to its direct access to Jalan Ngaglik and the presence of green open space between the two railway tracks, which remains underutilized (Liu et al, 2023).. Based on these conditions, landscape planning in the open space adjacent to the railway corridor is essential to create harmony between the railway infrastructure and its surrounding area. Such planning can provide both physical and visual services for users of railway transportation and help maintain the environmental balance of the railway edge area. This landscape arrangement also functions to shape and support the existence of a harmonious urban landscape (Zhang, 2023). With the arrangement along the railway corridor, open spaces will provide a positive image for the area and can become a point of interest for the city of Surabaya (Siregar, 2022).

Modern railway corridor planning has evolved significantly toward more sustainable and integrated approaches (Jurković & Lovoković, 2023). Railway transportation systems are intrinsically connected to environmental sustainability issues, including ecological preservation, optimal utilization of natural resources, and development expenses that are significantly affected by corridor planning and geographical positioning. These methodologies seek to enhance transportation effectiveness while simultaneously integrating ecological factors as fundamental principles for comprehensive and environmentally responsible planning strategies (Milewicz et al, 2023). Contemporary corridor planning also emphasizes the need for strong coordination between railway station development and the spatial configuration of its surrounding area. The success of urban rail transit systems in delivering optimal social, ecological, and economic benefits is highly dependent on alignment with sustainable urban development principles (Pulido et al, 2018). In this context, railway stations hold significant yet often untapped potential to act as catalysts for sustainable mobility and the formation of environmentally responsible cities (Lio et al, 2024). Additionally, while urban rail transit systems support the growth and expansion of metropolitan areas, the changing spatial structure of cities also directly influences the configuration and efficiency of these transit networks (Karlson, 2016).

Although several studies have discussed the importance of buffer zones and green belts in the context of railways (Zhang et al., 2023), ecological approaches to railway corridor planning in densely populated urban areas such as Surabaya have not been specifically explored in depth. Previous research has primarily focused on technical and transportation aspects, without emphasizing the integrated functions of ecology, society, and spatial planning (Jiang et al., 2024). Therefore, a new, more adaptive and environmentally friendly approach is needed through the concept of the Eco Railway Corridor. The objective of this study is to reorganize the spaces along the railway corridor currently undergoing land-use conversion into informal settlements so that they align with the function of supporting railway infrastructure while also being spatially safe and appropriate. In addition, the study aims to integrate physical and ecological elements into the

landscape design of the railway edge area to enhance environmental quality, visual comfort, and support the city's aesthetics.

RESEARCH METHODS

In the design process, which includes both architecture and urban scale, several stages are required to achieve the objectives of a design. To create a well-planned design, a theme is needed a collection of several concepts that provide design criteria (Gehl, 2019). A concept is a meaningful collection of ideas or thoughts used for classification or categorization through a term or a series of words (Jiang et al, 2024).

Data Collection Techniques

Data collection is the initial stage in the research process, where the gathered data must align with the facts or main issues being studied. The use of appropriate data collection techniques plays a crucial role in research, as it supports the data analysis process and ensures the continuation of subsequent research stages. This subsection provides a detailed explanation of the techniques used in data collection. The following is an elaboration of the data collection process for each aspect of the research, based on the methods applied (Saputri, 2022).

Tabel 1. Data Collection

No	Type	Method	Explanation
1	Primary Data	Observation	- Observation of the physical condition of the railway track area along the Ngaglik Road corridor. - Observation of user activity and behavior using Behavior Observation techniques, including behavior mapping or activity mapping and physical trace observation.
		Interview	- Interviews with local residents regarding their impressions and input regarding the railway boundary on Jalan Ngaglik Surabaya
		Documentation	- Immortalizing existing images or photos - Recording the atmosphere during a site visit
2	Secondary Data	Literature Survey	- Physical literature on the railway corridor along Jalan Ngaglik, Surabaya, human activities, and community behavior - Related articles and publications

Research Paradigm

Every research requires a paradigm as a fundamental approach to perceiving, thinking, evaluating, and conducting studies related to a specific aspect of reality. A paradigm serves as a philosophy, analytical theory, and logical framework necessary for understanding the entire research system (Sheydayi et al, 2023). It forms the basis of how research comprehends a problem and determines the testing criteria used as a foundation for addressing research questions. In line with this, the paradigm adopted in this study is post-positivism**,** in which the relationship between the researcher and reality must be interactive. Therefore, it is necessary to apply the principle of triangulation**,** which involves the use of various methods, data sources, types of data, and so on (Shannon-Baker, 2023)

Strategy Determination

The determination of the strategy used in this research requires an understanding of the research objectives. First, this study aims to identify the causes of land-use changes along the railway edge on Ngaglik Street, Surabaya. The second objective is to formulate design criteria for restoring the function of the railway buffer zone as a green corridor to support railway activities.

In this context, the design criteria can be derived from the analysis of the study area (Kim et al, 2025).

Research Method

This study employs a descriptive qualitative approach as its primary research methodology. The descriptive qualitative research strategy seeks to provide comprehensive understanding of phenomena through systematic data gathering and analysis. This method is chosen because it views the object as dynamic and holistic, with interrelated elements that cannot be separated. Additionally, direct interaction between the researcher and the object of study is necessary. However, the researcher must remain neutral and not have any particular bias (Saputri et al, 2019). The main strength of qualitative research lies in its ability to capture the richness and complexity of life with adequate depth and quality (Saputri, 2025).

Urban Planning

Urban planning necessitates a systematic methodology encompassing multiple phases to achieve the intended design goals. The urban planning process must adhere to a structured progression of sequential phases. This methodology comprises four fundamental components: examination, integration, assessment, and implementation. Each phase is described below:

1. Investigation is the initial stage in which the project's objectives and goals are classified and formulated, while the information pattern remains in an exploratory and evaluative phase. In the implementation of this research, both primary and secondary data were collected through surveys conducted along the railway buffer zone on Ngaglik Street, Surabaya, interviews with the local community, and the formulation of design objectives and targets to serve as the foundation for the next phase.
2. Integration is the creative phase where key concepts begin to be developed and produced, leading to the formulation of various alternatives in spatial organization and layout. In this research, core planning concepts were formulated based on the chosen theme—eco railway corridor, connectivity, and public space. This phase included developing alternative railway corridor designs involving variations in land use, circulation patterns, green open space areas, and transportation integration along the railway buffer zone on Ngaglik Street, Surabaya.
3. Assessment is the evaluation and review phase, where the previously developed concepts are critically analyzed to establish design standards derived from findings in the earlier investigation stage. In this study, the final design selection was carried out based on ecological criteria, resulting in the formulation of design standards for the railway buffer zone along Ngaglik Street, Surabaya.
4. Implementation is the final stage in which conclusive decisions are finalized and reorganized into increasingly detailed design stages. These decisions stem from a comprehensive assessment. The formulated criteria were synthesized into a macro concept for the railway buffer corridor on Ngaglik Street, Surabaya. (Elrahman, 2019).

RESULTS AND DISCUSSION

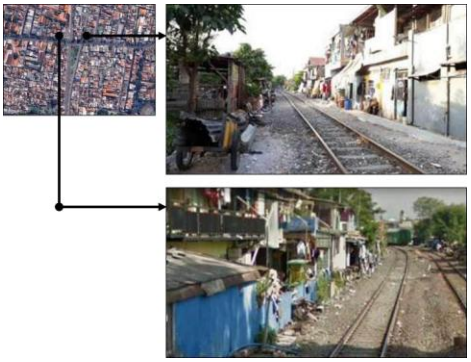
The selected study area is the railway edge zone along Ngaglik Street in Surabaya, which is currently occupied by dense residential settlements. These settlements are located in very close proximity to the railway tracks, whereas this area should be utilized as outdoor space or open space to support railway-related activities. Therefore, the existence of these settlements violates land use regulations, as the area is designated to function as open space. The following are the boundaries of the study area along with their descriptions:

Figure 1. Location Boundaries

Survey Result

Tabel 2. Survey Result

No	Documentation	Explanation	References
1		There is a land ownership sign belonging to PT. KAI located near the railway track on Ngaglik Street, which is currently occupied by permanent residential settlements. However, the area was originally designated as a green corridor, not a residential zone. The greenbelt along the railway track was intended to serve as a buffer zone to ensure the smooth operation of train traffic and to safeguard the safety of both train operations and the surrounding community. Therefore, the current land use can be categorized as a violation of the Surabaya City Spatial Plan (RTRW) for the 2010–2030 period.	- Railway operational space (right-of-way): The area designated for rail operations and its supporting facilities. - Railway supervision zone: An additional area of approximately 9 meters from the railway track intended to ensure the safety and security of railway operations. (Law No. 23 of 2007 on Railways). - Minimum right-of-way width: 6 meters from the edge of the railway track, with an additional supervision zone of at least 9 meters from the edge of the right-of-way (Government Regulation No. 56 of 2009, Article 59). - Land use within the railway right-of-way is only permitted for supporting infrastructure (such as pipes, cables, towers), not for residential purposes (Government Regulation No. 56 of 2009, Article 59).

2		There are residential settlements located along the edge of the railway track at a relatively close distance to the rails. This condition poses a threat to the safety and security of the residents living in the surrounding area. As previously mentioned, this area was intended to function as a green corridor serving as a buffer zone to protect railway traffic and ensure the operational safety of both the trains and the surrounding community.	- It is prohibited for any person to construct buildings, fences, embankments, or plant tall trees along railway tracks if such actions obstruct clear visibility or endanger railway operations (Law No. 23 of 2007 on Railways, Article 178) - Railway Operational Space (Rumaja) and Railway Right-of-Way (Rumija) are designated as sterile zones around the tracks, extending at least 6 meters from the centerline of the rail, while the Railway Supervision Zone (Ruwasja) adds a further 9 meters to ensure operational safety. (Government Regulation No. 56 of 2009, Article 59)
3		Local residents living near the railway tracks often carry out activities in very close proximity to the rails. In fact, there are chairs placed along the railway line, which are used by residents for sitting or resting. This situation poses a serious risk to both railway traffic safety and the safety of the people engaging in activities near the tracks.	- It is prohibited to construct, place objects, or position items on railway tracks that may obstruct clear visibility or endanger train operations (Law No. 23 of 2007 on Railways, Article 178) - The public is prohibited from entering the Railway Operational Space (Rumaja) to engage in activities such as dragging, placing, or using the railway tracks, except for railway operational purposes. (Law No. 23 of 2007 on Railways, Article 181a)
4		The open space along the edge of the railway tracks is currently being used as a dumping ground by residents from the surrounding settlements. This open space is not being utilized properly or optimally, leading the community to treat it as a waste disposal area. This	It is prohibited to dispose of waste outside designated disposal sites. (Law No. 18 of 2008 on Waste Management, Article 29)

		condition creates a slum-like and unattractive impression, further deteriorating the image of the surrounding area.	
5		The non-permanent settlements located in the open space along the edge of the railway tracks should be relocated. The presence of these settlements may encourage other residents to establish similar informal housing. Over time, there is a risk that these temporary structures will gradually evolve into permanent settlements due to continuous land occupation.	It is prohibited to establish settlements in locations that may endanger residents or the operation of infrastructure, in accordance with the principle of *upfront relocation* or preventive relocation (Law No. 1 of 2011 on Housing and Settlement Areas, Article 140)
6		There is open space around the railway tracks that can be optimally utilized to support railway activities while also providing benefits to the surrounding community. This area should be redesigned into a more attractive, aesthetic, and functional open space.	- Designating the green buffer zones along railway tracks as Green Open Space (GOS) with specific functions, aimed at limiting public interaction with the railway and ensuring operational safety (Ministry of Public Works and Housing Regulation No. 5 of 2008 on the Provision and Utilization of Urban Green Open Spaces) - Unused open spaces (dead spaces) along railway lines create a slum-like image, degrade the city's visual quality, and reduce the comfort of train users. A comprehensive and integrated redesign is needed to improve the environment both visually and functionally, while also supporting local economic value and benefiting PT KAI (Merabono, 2002)

Previous Research

The following is previous research used in the literature study of this research.

Tabel 3. Previous Research

No	Research Name	Research Tittle	Research Result
1	Alfred Wijaya, Sally Octaviana Sari (2020)	Analysis of design criteria for pedestrian paths in the Padalarang railway station area	- Billboard placement does not obstruct pedestrian circulation - Provides sufficient free space for waiting - Drainage channels do not use open grills that endanger pedestrians - Selection of strong, non-slippery and non- glaring materials - Relocation of street vendors to the planned location - Planting trees for shade at a certain distance
2	Albert Tonghoon Han, Thomas L. Daniels, Chaeri Kim (2022)	Managing urban growth in the wake of climate change: Revisiting greenbelt policy in the US	- Farmland and grasslands require proper management to provide substantial carbon sinks. - Urban designers, government representatives, and community stakeholders ought to advocate for establishing green corridors and safeguarding woodland areas and wetland ecosystems to function as carbon absorption zones. - Within counties designated as green belt areas, carbon retention and capture capabilities demonstrated superior performance compared to adjacent metropolitan regions that lacked similar green belt designations.

Planning Criteria

Based on the results of the analysis and literature review on the spatial planning criteria for railway edge areas within the theme of an eco railway corridor, the following describes each aspect considered in the design process.

Tabel 4. Aspects and Planning Criteria

No	Aspect	Planning Criteria	Implementation
1	Integrated Sustainability: Landscape	Sustainability, Design, and Construction	Landscape planting and materials are locally sourced and maintained through organic methods, aiming to reduce waste, emissions, and environmental pollution. Maximizing the use of local stone for paving and wall cladding, as well as bamboo and wood, in order to reduce the carbon footprint (Susanto, 2018).
		Energy and Climate The reforestation of the Ngaglik railway	The reforestation of the Ngaglik railway corridor is intended to absorb carbon emissions and enhance the microclimate along the corridor. Trees planted along the route will also contribute to shielding both existing and future buildings, helping to create a cooler environment. The first row of trees in the park is planted approximately 7.5 meters

			from the center of the railway track to ensure that their canopies do not interfere with the line in the event of strong winds or fallen trees. The selected vegetation consists of low-risk, wind-resistant species. These plantings serve to stabilize the soil, cool the microclimate, enhance aesthetics, and support biodiversity (Schrodi, 2023).
2	Integrated Sustainability: Hardscape	Retaining Walls	Retaining walls along the Ngaglik railway corridor are constructed using locally sourced granite blocks. The layout of these stones follows a lateral pattern, designed to reflect the rhythmic structure of railway tracks. Retaining walls along the railway corridor must account for lateral loads caused by train vibrations, including live loads and the potential for overturning or sliding. The system utilizes interlocking block structures. For gravity retaining walls, which rely on their own weight for stability, the design criterion requires that the resultant force falls within the middle third of the foundation base when placed on soil (AREMA, 2003)
		Stairs and ramp	Due to the presence of multiple separate entrances along the corridor, certain areas necessitate the construction of ramps and stairs to address minor elevation differences. In locations with steep terrain, where stairs are no longer suitable, stone retaining walls will be implemented. These walls are designed with substantial height, structural reliability, and the capacity to support surrounding vegetation. The ramp design features a slope of ≤6° (1:10), which is ideal for accessibility and friendly to persons with disabilities. Each landing is at least 1.5 meters long (or 2 meters if the ramp exceeds 9 meters in length), serving as a resting or wheelchair maneuvering area. Stairs are designed ergonomically, with risers ≤ 15 cm, goings ≥ 28 cm, and non-slip surfaces (Regulation of the Minister of Public Works and Public Housing No.14/PRT/M/2017 and Circular Letter of the Minister of Public Works and Housing No. 2/2018).
3	Integrated Sustainability: Lighting	Lighting Source	The typology is based on areas with relatively high activity. To conserve energy, most of the corridor lighting is equipped with LED fixtures that are electronically controlled. LEDs have high efficacy (lumens per watt), making them more efficient than fluorescent, halogen, or sodium lamps. They do not contain mercury, produce minimal heat, and are

	easily controlled electronically due to the corridor lighting system using automatic on/off mechanisms. Lighting is focused in high-activity areas (platforms, entry access, crossing zones) with sufficient light intensity (for example, 100–150 lux for platform areas) and uniform illumination (Indarto, 2023).
Lighting Area and Accent Lighting	Standard lighting fixtures mounted on poles will be utilized along the entire corridor. Stairs and ramps will be highlighted as design features along Ngaglik Street, enhancing wayfinding and emphasizing access points. Stair handrails will be integrated with lighting elements to illuminate the lower walking surfaces, while bridges will also feature handrail-integrated lighting to provide consistent illumination to the ground plane. LED light poles are installed rhythmically following the contour of the railway, with varying heights (8–12 meters), depending on the width of the corridor and the required light intensity (Hermanu, 2019).
Transit Platform Lighting	Transit areas will be well-lit to ensure safety, enhance utility, and emphasize architectural expression. At night, these facilities are intended to serve as friendly and recognizable landmarks. The canopy structure will offer a sheltered, comfortable, and inviting environment for passengers waiting for transportation. With proper lighting, structures such as canopies and staircases can become visual landmarks at night, as the illuminated forms are easily recognizable and inviting for users to wait comfortably. In addition, the linear pole lighting design follows the rhythm of the tracks and space planning, creating a consistent lighting corridor that reinforces the sense of place in accordance with architectural principles (Shodiq, 2017).

CONCLUSION

The *Eco Railway Corridor* theme on Ngaglik Street is a concept that transforms disused railway tracks into active public spaces for the local community. Through the arrangement and revitalization of the railway corridor, the former rail line is reactivated with the integration of eco-friendly design elements in landscape, hardscape, and lighting. This corridor planning pays attention to the surrounding environmental conditions, which are viewed as potential assets of the site. As a result, users will experience a unique atmosphere and sense of place during their movement through the corridor. This design approach responds to the existing problems along the Ngaglik railway edge corridor. These problems include the conversion of railway-side open spaces into residential areas, the presence of housing located too close to the tracks, and daily community

activities occurring near the railway, which disrupt train operations. The proposed planning aims to restore the function of these railway-edge spaces as open public areas designed with a focus on comfort and safety for the surrounding community. Furthermore, the project will enhance the area's identity and provide open spaces that benefit local residents both functionally and aesthetically.

ACKNOWLEDGEMENTS

We would like to the Bhinneka PGRI University community for their knowledge and guidance.

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