



Utilizing Railway Right-of-Ways as Environmental and Recreational Spaces: An Analytical Study in the Municipality of Dora

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<https://doi.org/10.18280/ijstdp.200203>

ABSTRACT

Received: 6 January 2025

Revised: 15 February 2025

Accepted: 18 February 2025

Available online: 28 February 2025

Keywords:

urban development, railway right-of-ways, urban green spaces, sustainable development, railway safety

Railway right-of-ways, traditionally reserved for transportation, present significant potential for development as environmental and recreational spaces, particularly in urban areas. In the Municipality of Dora, the active railway line is crucial to the region's transportation network, yet the adjacent lands remain underutilized and could be transformed into spaces that benefit the community. The key challenge lies in balancing the operational integrity of the railway with the local community's aspirations for green and recreational developments. This study aims to assess the preferences of local residents and key decision-makers regarding the potential development of the railway right-of-way in Dora. The goal is to propose sustainable solutions that align with both the community's desires for enhanced green spaces and recreational areas and the operational needs of the railway. The broader objective is to create a framework that can be applied to similar urban spaces with active railways, ensuring that the infrastructure can coexist with community-oriented developments. The findings show strong community interest in utilizing the railway right-of-way for recreational and environmental purposes, with particular emphasis on green spaces, walking and cycling paths, and community gardens. However, stakeholders highlighted the importance of addressing safety, budgetary, and environmental challenges in the development process. The proposed solutions provide a balanced approach that integrates community needs with the technical and safety requirements of the railway, offering a blueprint for sustainable urban development in other contexts with active railways.

1. INTRODUCTION

Railway lines have long provided critical connection corridors between cities, towns, and regions. Yet over the past decade there has been an increasing interest in revisiting how these spaces could be repurposed as multi-functional environments that benefit environmental sustainability and community health. Incorporating green spaces and recreational facilities within these corridors allows urban planners to repurpose underutilized or formerly industrial areas into thriving community assets. This approach not only maintains the core transport functionality of these lines, but also enhances the quality of life in communities adjacent to these railways.

In the case of the Municipality of Dora, unlike the previous two cases, the railway is still active and operational, however, the land surrounding the railway has potential for development. Unlike abandoned rail lines used for other purposes elsewhere, the Dora railway is a busy line that is part of the region's transport network. Thus, any proposal to develop parcels in the railway's right-of-way will need to weigh the operational

needs of the railway against the desires of the local community for green and recreational space.

1.1 Problem statement

In the Municipality of Dora the main challenge is to achieve a good balance between the use of the railway for operational and developmental purpose along the right-of-way for environmental-recreational activities. There is a lot of interest in using these areas for the benefit of the local community, but the railway's active status presents challenges that must be carefully navigated. This is a situation that requires a nuanced approach, as we balance safety and functionality of the railway with access while also seeking opportunities to create environmentally sustainable and socially beneficial green spaces.

1.2 Research objectives

The aims of this study are twofold. The study first seeks to evaluate local residents' and key decision-makers' preferences

and attitudes toward development along the railway right-of-way in Dora. Last week we learnt more about community preferences on the station design, drinking, dining and other activities proposed by the tram train in regards to the station. Secondly, this study aims at suggesting sustainable development opportunities, which matches with both community's will and railway's operation system. These solutions can serve as a template for the creation of similar spaces across other urban cities where active railway right-of-ways exist.

1.3 Research questions

This study is guided by the following research questions:

What are the preferences of the local community and stakeholders regarding the use of railway right-of-ways in Dora?

How can these spaces be developed to enhance environmental and recreational value without disrupting the operational functions of the railway?

1.4 Significance of the study

This work contributes to the urban planning literature by tackling the multilayered problem of railway right-of-way development in places where the railway is active. This study will help inform urban planners and policymakers who must find a balance between maintaining essential transportation systems and improving the livability of cities. This study can lead to a considerable improvement in the quality of life in the Municipality of Dora by providing viable and applicable solutions to the operational needs of the railway as well as the recreational needs of the community.

2. LITERATURE REVIEW

2.1 Overview of railway right-of-ways as multi-functional spaces

Until recently, railway right-of-ways were meant solely for transportation, but there is now an international movement to repurpose them into green and recreational corridors. This trend is driven by growing demands to incorporate green infrastructure into urban landscapes, as well as to build spaces for informal recreation in communities. Whether this plan is in spirit or action, and this development, proves a growing recognition that railway corridors can better serve the city that they bisect by building shared spaces.

These practices have emerged elsewhere in this country and globally as railway right-of-ways reimagined as green corridors and recreational trails. The USA's "Rails-to-Trails" program, which has been active since 1986, is one of the successful endeavors of the aforementioned initiative, now more than ever repurposing once abandoned beams into outdoor recreation and conservation trails for the public [1]. Likewise, in the China, the environmental efficiency of the railway systems has been improved by incorporating sustainable notions into the design and operation of the railway infrastructure. This includes the application of green technologies and prudent management of ecological impacts along the railway corridors [2].

The concept of "Railway Ecology" is created in Europe to face the environmental problems related to rail transport, as

well as the biodiversity issues caused by railway space occupation, which have the main goal of associating rail transport planning with ecology [3]. Both transportation route and veritable pocket of environmental asset, this method further embodies the intrinsic value of preserving or even enhancing the natural habitats there in.

And they can take a look elsewhere for the best practices for how to maximize railway right-of-ways in cities and municipalities. Through the same mechanisms, we can create spaces that promote a sustainable ecological future and physical well being of our communities but do so without ruining the delicate operational system that puts food on our tables.

This review of global practices suggest that a holistic railway corridor available management strategy, which not only be responsive to transport demand; but also considers in meeting the rising pressures in urban greenery and recreational space demand.

2.2 Sustainable development of urban green spaces

An important component in shaping livable, resilient cities. Green spaces enhance the aesthetic value of urban areas, providing significant environmental, social, and economic gains. More specifically, sustainable development principles emphasize an integrated approach that reflects social, economic and environmental interests.

Connectivity is one of the cornerstones of sustainable development of urban green spaces. It forces the gardens to become united, to function as conduits for which mother nature, and the creatures that rely on her, can pass without block, and residents can still travel through with the green recreational spaces. This interlinkage ensure that green areas are not little pieces in a bigger mosaic, but rather a component of a more extensive linking framework, which maintains biodiversity and creates integrated biological services [4].

Another integral principle is multifunctionality, whereby green spaces are not exclusively planned for one use, such as recreation, but also for water management, habitat preservation and so forth. By adhering to this principle, urban green spaces can be not only multi-functional in order to meet diverse needs of urban populations growing over time but also sustainable from an environmental point of view in production [5].

Community participation at various decision-making levels in the planning and management of urban green spaces is important for their sustainability. Emerging form of architecture through collecting reuse details involving connect sharing of knowledge and exploring new ideas, trending in the world [6]. Moreover, this participatory method also help develops ownership and responsibility of the resident that is essential for the maintenance and preservation of green spaces [7].

Another critical urbanism principle is the incorporation of green spaces. This includes making green infrastructure part of the overall design of urban landscapes, and making sure green spaces are not just an afterthought but a key part of the plans of urban development. This integration facilitates the build environment conserving balance between development and ecological conservation of cities [8].

Following these principles will help in making sure that green spaces are beneficial for sustainable cities as well as ecological services, urban residents, and all biodiversity in urban places.

2.3 Economic aspects of railway right-of-way transformations

As does, like in any part of the world, money does not grow on trees, thus realising the economic fallout of repurposing railway right-of-ways into multifunctionably utilizable space may help shed light on how best to execute such endeavours, particularly for developing countries. New studies emphasize that we need to focus on not only the upfront implementation costs but also the high potential for long-term economically advantageous outputs coming out of the projects. Cost-benefit analyses of projects in Latin America and Southeast Asia show this principle at work: the immediate cost of green infrastructure and public space development is high, but the long-term benefits, such as higher property values, better public health, and increased local tourism, typically make up for the upfront cost [9].

Railway corridors can also be transformed into public spaces which can also attract private investment creating opportunities for public-private partnerships [10]. Research in Brazil and India shows that through the partnership between private investors in the development and maintenance of public spaces, these can be implemented with less financial impact in municipal coffers [11]. In the Municipality of Dora, this principle seems especially crucial, as the public investment may be limited by a lack of funding.

Additionally, the economic impacts of better urban mobility and environmental sustainability are well-known. Make use of every inch of green space for recreation, so that residents are active in their community, lessening public health costs and creating productive citizens. These medium-term economic gains are especially needed for developing nations like Iraq, where cities are quickly getting more people and infrastructure is seeing strain [12].

2.4 Railway right-of-way projects in the Middle East

While the transformation of railway right-of-ways into multifunctional spaces has been extensively documented internationally including in the western world and the Far East, there is a dearth of projects in the Middle East and especially those in countries such as Iraq in the literature. The local environmental, cultural and socio-economic conditions come together in the region to create both opportunity and challenge for this kind of development. This, combined with the account that there are extreme climatic conditions, including high temperatures and scarce amounts of rainfall, makes it difficult to, for example, green spaces, which would require innovations, such as drought resistant plants and water wise irrigation systems [13].

Culturally, the design and use of public spaces in Middle Eastern cities are shaped by social norms and traditions, which emphasize the need for spaces that accommodate large families and social gatherings. This has implications for the design of railway right-of-ways, where multi-use areas must cater to recreational activities while providing sufficient shade and comfort during hot weather [14].

Economically, the region faces challenges related to limited public investment in infrastructure projects due to political instability and budgetary constraints. However, some countries have successfully attracted private investments and partnerships in urban development projects, demonstrating that public-private collaboration is a viable model for transforming underutilized railway spaces [15].

Urban planning and governance also present additional hurdles, especially in Iraq, where the Municipality of Dora can be found. Insufficient planning frameworks (the subject of the next lesson) and the limited ability of municipal governments to absorb large-scale investments also stymie well-functioning railway right-of-way transformations. However, within Iraq railway corridors present the opportunity to incorporate green spaces that can act as a remedy for the which are significantly lacking within its population dense cities [12].

2.5 Case studies of successful railway right-of-way transformations

The repurposing of railway right-of-ways for public use has gained popularity in recent years, particularly in cities looking to improve urban connectivity and sustainability. In this regard, we explore the case studies of active railways been transformed into multifunctional spaces alongside the railway right-of-way, with the goal of meeting transportation needs as well as complying with social, environmental and economic objectives.

2.5.1 The Sydney Light Railway right-of-way, Australia

The transformation of the line is a further example of where an operating railway can be reused to create public spaces that enhance urban livability, with the most notable inclusion being the Sydney Light Rail project. The project was to accommodate greater public transport capacity while making space for pedestrians and cyclists.

Implementation: The reconfiguration ensured that the light railway right-of-way had dedicated pedestrian and cycling routes aligned next to the rail lines, connecting to the wider cities' transport systems. Noise-reduction technologies were implemented to limit disturbances to nearby residents. New landscaped parks as well as green-certified station designs have been developed to work with the surrounding area of the corridor. One of the major factors yielding success was involving local stakeholders in the planning to create spaces that met the needs of the community [16].

Through a critical lens: The project's integration of public spaces with a working public transport line was widely praised, though it was also criticized for delays and cost overages. These problems slowed public approval, although the end result made a huge difference in increasing mobility in urban areas and enhancing access to urban greenery. In addition, the project demonstrated the need for new transport infrastructure to be matched to existing community amenities in order to gain the most from urban rail renewals (Figure 1).



Figure 1. The Sydney Light Railway right-of-way, Australia
Source: [17]

2.5.2 The Yamanote Line, Tokyo, Japan

This project is a good example of how an urban rail line with high passenger traffic can harmonize with green public spaces and commerce shops to bring multi-functional benefits to the society while improving transport function.

Operation: JR East, the Yamanote Line’s operator, created green corridors and commercial areas alongside the railroad. The focus was on improving pedestrian paths, small parks, and retail nodes near station access along the way to make optimal use of underutilized land. Green technologies were integrated, including solar 1: lighting for stations and sound barriers to reduce environmental impacts from development [18].

Introduction: The Yamanote Line transformation is an iconic example of such a project, contributing to urban revitalization efforts in Tokyo in the 21st century. This caused property values to increase and certain areas to gentrify. A throwing example of the perennial tension arising in urban railway repositionings between the enhancement of economic development potential and a drive to keep public places affordable and accessible for all residents (Figure 2).



Figure 2. Yamanote Line train in Tokyo, Japan
Source: [19]

2.5.3 Mumbai, India

Mumbai, the financial hub of India, has one of the busiest railway networks across the globe. The Mumbai Suburban Railway is an above-ground railway network of the Mumbai local area, serving millions of commuters every day. Mumbai is one of the only cities in India where rail-based transportation projects have included areas outside of the railway right-of-way, using land between rail and road to create featured spaces aimed at improving public life, to help alleviate some of the city’s stifling urban congestion.

In Mumbai, however, railway right-of-way spaces have been reclaimed over the past few years to make room for pedestrian-friendly spaces and greenery along the railway lines. The adjustments had been made in an effort to minimize pedestrian fatalities and guarantee that local residents could reach their railway stations. This included safety upgrades along railway lines with raised walkways, footbridges and greenery. These corridors also included the development of commercial spaces so as to smooth functioning logistic of railway network as well as benefit the economics of the people [20].

MMRDA worked on a project called Mumbai Rail Infrastructure Upgradation Project (MRIP), which upgraded

the infrastructure along the railway corridors, including railway stations, tunnels, bridges, and other high-capacity public transportation corridors. The railway rights have been widened and included pedestrian ways and sound barriers with landscaping to minimize noise pollution. These changes played a critical role in enhancing urban connectivity while ensuring the efficient operation of the railway network [20].

The project of uplifting the railway right-of-way in Mumbai has resulted in substantial improvements in pedestrian safety and urban environments, but the development has encountered challenges with land acquisition and in relocating informal dwellings. The success of MUTP in harmonizing public spaces and railway infrastructure can be mirrored in other compact cities like Baghdad. While the Mumbai case is focused on the use of above-ground railway corridors for urban development and public amenities (Figure 3).



Figure 3. Mumbai suburban railway
Source: [21]

2.6 Comparison of case studies with the local context of Dora Municipality

Analysing the experiences of successful corridor transitions in Sydney, Tokyo and Mumbai provides an important framework for understanding how these practices are applied globally. However, there are fundamental differences between these projects and the context of Dora Municipality, which requires adapting global solutions to suit local realities. The following table shows a comparison between these three cities and Dora Municipality in terms of railway status, development pattern, challenges, opportunities, and community participation (Table 1).

2.7 Gaps in existing research

While there is a growing enthusiasm for repurposing existing railway right-of-ways for multiple uses, the literature is thin concerning how this translates into diverse models of community co-design — especially for live railways. Much of the research has historically focused on repurposing abandoned or disused railway right-of-ways, which brings different considerations than active railways. Active uses of the surrounding site related to rail, along with other environmental and recreational uses, raise new safety, accessibility, and logistics issues that have not yet been fully analyzed in the existing literature [22].

Table 1. Comparison between the transformations of railway corridors in global cities and the context of the Municipality of Dora

Item	Sydney (Australia)	Tokyo (Japan)	Mumbai (India)	Dora Municipality (Iraq)
Railway status	Running with urban modifications	Running with commercial and green exploitation	Busy rail network with gradual upgrades	Operational but not exploited urbanly
Development pattern	Pedestrian paths, green spaces, commercial areas	Green spaces, commercial stations, environmental improvements	Pedestrian spaces, urban development, green spaces	The possibility of converting adjacent lands into gardens and pedestrian paths
Challenges	High development costs, implementation delays	The need to balance development with transport intensity	Traffic challenges, space constraints	Lack of integrated urban planning, poor funding
Opportunities	Government Support, Sustainable Projects	Commercial investment, advanced environmental solutions	Infrastructure improvement, local economic support	Possibility of using unused land, reducing slums
Community Engagement	Involve the population in planning and decision-making	Strong local support, business partnerships	Local support but with operational challenges	Poor community participation and the need to promote awareness

Another important gap is the extent of community participation in the planning and implementation stages of such developments. In urban planning or development processes, citizen participation is widely known but the mechanisms through which actors are involved in decision making processes, especially active railway spaces, have been less documented. Communities are often not specified in research reporting how they are involved, and the focus is on what outcomes occur as a result of participation but often not how those outcomes came to be [23].

In addition, engaging communities in active railways projects—where operational issues take precedence—is a largely unexplored challenge. People have studied community engagement in other kinds of infrastructure projects, but the unique dynamics involved with community engagement for active railways have not been addressed. This gap indicates there is opportunity for more granular exploration into how best to incorporate community feedback into planning procedures without losing operational efficiency for rail systems [24].

The review of literature reveals a significant gap in research specifically related to the transformation of railway right-of-ways in developing countries, particularly in the Middle East and North Africa (MENA) region, including Iraq. While global case studies from countries such as the United States, Japan, and Russia offer valuable insights, the unique socio-economic and urban planning challenges faced by developing countries are often underrepresented in the literature. Studies conducted in other developing regions, such as Sub-Saharan Africa and South Asia, provide relevant insights into the integration of railway infrastructure with community spaces. For example, Blumenfeld et al. [25] highlight the need for technical strategies tailored to low-income countries where resource limitations and governance challenges play a critical role in shaping railway infrastructure projects. Additionally, Wangai et al. [26] examine sustainable railway development in Kenya, focusing on balancing technological advancements with socio-economic constraints, a challenge also relevant to Iraq. These studies underscore the importance of developing localized strategies that address both community needs and operational requirements, which is crucial for the successful transformation of railway right-of-ways in Iraq and other developing countries.

3. RESEARCH METHODOLOGY

3.1 Research design

This research uses mixed-methods design with the integration of quantitative and qualitative data. This lever in summary was chosen for giving in summary the perception of local people such as residents and stakeholders about the use of railway right-of-way in Municipality of Dora. Quantitative data were drawn from structured surveys the authors conducted with the local population and qualitative data were drawn from interviews, as well as document analysis. This research design adopts a convergent parallel mixed-methods approach involving a statistical analysis of contemporary trends and qualitative methods by way of case studies to provide a holistic view of the trends and matters of developing railway environments.

3.2 Data collection

3.2.1 Surveys

Survey design: The survey will target local residents and various stakeholders, including the Municipality of Dora. This survey seeks to learn about residents' preferences and attitudes on the possible transformation of the railway right-of-way into recreational and environmental amenities. Questions are structured to assess various aspects like interest in green spaces, possible uses for the space and worries about safety and noise. It combines Likert scale questions quantifying preferences with open-ended ones counsel qualitative feedback.

3.2.2 Questionnaire design and validation

The questionnaire used in this study was developed based on a review of previous literature on the reintroduction of railway corridors, along with consultation with urban planners to ensure its relevance to the local context.

The questionnaire included a set of closed and open questions, with the use of a 5-point Likert scale to measure residents' preferences about the development of the railway corridor in the Municipality of Dora. The questions included the following themes:

- **Environmental preferences:** Assess residents' desire to add green spaces and pedestrian walkways.

- **Safety:** Concerns about proximity to railways and how to improve safety.
- **Infrastructure:** Residents' opinion about the addition of new facilities such as bicycle lanes and resting areas.
- **Community participation:** The extent to which residents are interested in participating in planning and implementation processes.

The questionnaire was distributed to 100 municipal residents, and the data was analyzed using Factor Analysis to identify key patterns that influence preferences. To ensure the accuracy of the results, the questionnaire has been carefully designed based on past literature and consultations with urban planning professionals.

3.2.3 Sampling strategy for survey and interviews

The stratified random sample was used to select 100 participants in the questionnaire, to ensure a balanced representation in terms of age and gender. The sample included 25% of the age group 18-30 years, 35% of the age group 31-45 years, 25% of those aged 46-60 years, and 15% of those over 60 years, with an equal distribution between males and females.

For the interviews, the Purposive Sampling sample was used to select 30 participants from urban planning (40%), environment (25%), transportation (20%), and research consultancy (15%), to ensure that their expertise is used to analyze the opportunities and challenges of the project.

3.2.4 Interviews

Semi-Structured Interviews: To further supplement surveys, semi-structured interviews are conducted with key decision-makers such as urban planning and municipal officials to gauge the constraints and opportunities relevant to the project. The purpose of these interviews is to obtain knowledge and insight on the technical, legal and financial challenges of developing the railway spaces, while preserving operational integrity. Semi-structured format enables exploring specific topics further (safety issues and environmental sustainability).

3.2.5 Document analysis

Document Analysis: In support of the primary data obtained through surveys and interviews, this study incorporates a detailed analysis of relevant urban planning documents and prior research concerning railway spaces. These documents include background on existing policies/guidelines and relevant case studies about the transformation of similar urban spaces in other contexts. This analysis will help in understanding best practices and challenges faced by each system, which in turn will inform the recommendations proposed for the Municipality of Dora.

3.3 Data analysis

3.3.1 Factor analysis

Factor Analysis: We will conduct factor analysis on the quantitative data we have collected from the surveys to determine specific themes and preferences expressed by the respondents. This productive form of this statistical method allows for the data to be distilled into key pieces that summarize the most important preferences and issues of the population when it comes to the development of the railway right-of-way. This analysis will demonstrate trends in the data, including what types of developments are more welcomed

(e.g., green spaces, recreational areas) and which concerns (e.g., noise, safety) are more concerning.

3.3.2 Justification for the use of factor analysis

Factor analysis was used to extract key patterns in participants' responses about the development of the railway corridor in Dora Municipality. This analysis helped identify key factors influencing residents' preferences and concerns related to the project, making it easier to interpret the results and make appropriate recommendations.

Three main factors were extracted that explain a large proportion of the variation in the data, representing the basic dimensions of population concerns and demographic preferences. This analysis helped identify the most acceptable types of development and key concerns such as safety and noise.

3.3.3 Thematic analysis

Thematic analysis: The qualitative data collected in interviews will be analyzed by thematic analysis. We first transcribed the transcripts of the interviews and coded them for common trends — e.g., stakeholder needs, tensions between operational realities and desires of the community and potential solutions for the future use of the railway right-of-way. A thematic analysis not only provides a better understanding of the nuances involved in these transformations but also situates the survey answers in a larger urban planning context.

3.4 Ethical considerations

Ethical Protocols: Ethical considerations are paramount in this research, particularly in conducting surveys and interviews. All participants are informed about the purpose of the study, their rights, and the confidentiality of their responses. Informed consent is obtained from all participants, and they are assured that their data will be anonymized and used solely for research purposes. The research adheres to the ethical guidelines set forth by the institution and the local authorities, ensuring that the research process is transparent, voluntary, and respectful of participant privacy.

3.5 Case study area

It is the most fought over real estate in the world. Dora is a working and populous area of Baghdad located on the west bank of the Tigris river, they also have industrial zones and palm trees in Dora. The region has approximate coordinates, 33.251389°N, 44.391944°E, Figure 4 and, based on 2017 data, has 272,531 inhabitants. Dora has undergone significant urban changes in the last few decades, strongly impacted by the economic and political changes of Iraq [27].

Recent years have seen widespread unauthorized conversion of agricultural lands to residential uses that have resulted in unregulated urban growth with haphazard development on land and excessive congestion on roads and infrastructure. Contractors and real estate developers exploited the lack of strict municipal oversight and have created an urban fabric capable of coexisting for both organized and unorganized areas. These unorganized agricultural lands can be found as entities, like the Al-Jazira neighborhood of the old payment, and the Al-Jami'ya neighborhood of organized residential development. This is visually reflected in the urban

form of the area where slow planned growth is juxtaposed to the fast, unregulated urban growth [28].

Even after the railway reopened as a transportation route, the right-of-way adjacent to these relatively untouched regions continues to be underutilized, and is thus the focus of the investigation presented in this study. These neglected spaces could become multifunctional environmental and recreational projects. These images demonstrate the layout of the railway tracks, the residential and industrial zones, and the feasibility of converting this into public space (Figure 5).

Looking at the geographic overview of the Dora railway right-of-way one can see some of the key features — the proximity to urbanized areas, the lot vacancy or underutilization along directions, the planned development of areas such as Al-Jami’ya compared to the less structured, dispersed developments in Al-Jazira — areas of both planned and irregular expansions. These images highlight the opportunities for increasing green infrastructure with parks, walking paths, and ecological buffers, that do not obstruct rail operations [29, 30].

The essential challenge is to work out how to balance the operation integrity of the railway so it can continue to move and service trains with the wider community needs for where the creek could be a green public space and parks. So these images highlight even more the importance of strategic urban planning to ensure the safety, environmental sustainability and the growing community demand for recreational space.

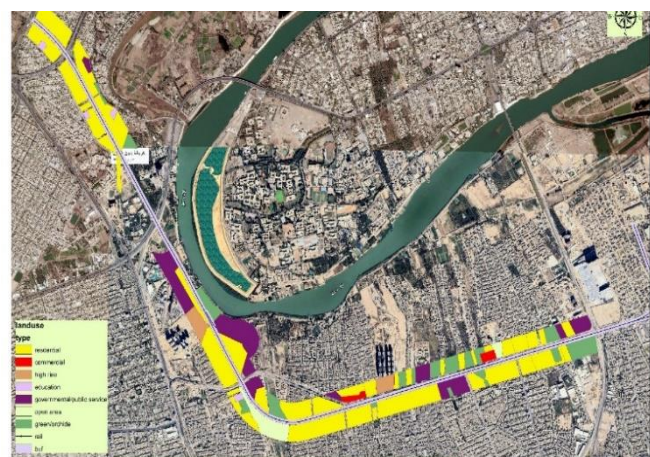


Figure 4. The Municipality of Dora



Figure 5. Geographical overview and urban features of the Dora Municipality railway right-of-way
Source: [31]

4. RESULTS

4.1 Survey findings

The survey conducted with 100 residents of the Municipality of Dora provided detailed insights into their preferences and concerns regarding the development of the railway right-of-way.

Demographics: The sample was diverse in terms of age, gender, and the length of time respondents had lived in Dora. The age distribution was balanced, with a significant portion of respondents falling into the 18-30 and 31-45 age ranges. The gender distribution was split evenly between male and female respondents. Additionally, over 50% of the respondents had lived in Dora for more than 10 years (see Table 2 for details).

Table 2. Demographic breakdown of survey respondents

Age Range	Count	Gender Distribution	Count	Residency Duration	Count
18-30	25	Male	50	Less than 5 years	20
31-45	35	Female	50	5-10 years	30
46-60	25			More than 10 years	50
61+	15				

Current Usage: A large portion of residents indicated that they rarely or never visit the railway area, with 35% falling into this category. Those who do visit primarily use it for recreational activities (40%) or commuting (30%). This suggests that the railway area is underutilized, but holds potential for increased community engagement if developed into a more inviting space. The distribution of responses is illustrated in Table 3.

Table 3. Current usage of railway area by residents

Visit Frequency	Count	Primary Use	Count
Daily	10	Commuting	30
Weekly	30	Recreational activities	40
Monthly	25	Walking/Cycling	20
Rarely/Never	35	Other (e.g., social gatherings)	10

Development Preferences: The residents showed a strong preference for environmentally oriented and recreational developments. The most popular choices were walking and cycling paths (25%), green parks (20%), and community gardens (20%). These preferences emphasize the community's desire for green and recreational spaces in Dora (see Table 4 for detailed preferences).

Table 4. Preferred types of development

Development Type	Percentage of Respondents
Walking and cycling paths	25%
Green parks	20%
Community gardens	20%
Playgrounds for children	15%
Cultural/Art spaces	10%
Outdoor sports facilities	10%

Importance of Green Spaces: A significant majority of respondents (70%) considered having green spaces in their neighborhood as "very important," aligning with their strong preference for parks and walking paths. This highlights the community's desire for accessible green areas.

Concerns: The primary concerns raised by residents included safety issues around active railways (30%), maintenance of public spaces (25%), and noise from trains (20%). These concerns suggest that residents are not only interested in developing the area but also in ensuring it is done in a way that addresses operational and safety challenges (see Table 5 for a breakdown of concerns).

Table 5. Key concerns regarding railway development

Concern	Percentage of Respondents
Safety around active railways	30%
Maintenance of public spaces	25%
Noise from trains	20%
Potential increase in traffic	15%
Other (e.g., cost of development)	10%

4.2 Interview insights

The interviews with 30 key stakeholders, including urban planners, environmental officers, and transportation officials, provided qualitative insights into the opportunities and constraints related to developing the railway right-of-way. The following key themes were identified:

Professional Background: The stakeholders represented a wide range of professional backgrounds. The majority were urban planners (40%) and environmental officers (25%), with the remainder consisting of transportation officials and other professionals such as consultants. This diversity ensured that the perspectives provided covered a broad spectrum of urban planning and environmental considerations (see Table 6).

Table 6. Professional roles of stakeholders

Role in Municipality	Percentage of Respondents
Urban planner	40%
Environmental officer	25%
Transportation official	20%
Other (e.g., consultant)	15%

Years of Experience: A significant proportion of the stakeholders had extensive experience in urban planning or related fields, with 50% having more than 10 years of experience. Another 30% had between 5-10 years of experience, while 20% had less than 5 years, indicating a mix of seasoned professionals and newer voices (see Table 7 for the distribution of experience levels).

Table 7. Years of experience in urban planning

Years of Experience	Percentage of Respondents
More than 10 years	50%
5-10 years	30%
Less than 5 years	20%

Perception of Current Railway Use: Stakeholders had differing views on the current usage of the railway right-of-way. While 40% believed the area was underutilized, 30% felt it was adequately used, and a smaller group (10%) considered it overused. Some (20%) provided additional feedback,

suggesting that the area needed reassessment to optimize its use (see Table 8).

Table 8. Stakeholders' perception of current railway use

Perception of Current Railway Use	Percentage of Respondents
Underutilized	40%
Adequately used	30%
Overused	10%
Other (e.g., Needs reassessment)	20%

Challenges in Development: Stakeholders identified several critical challenges to developing the railway right-of-way. The most commonly cited issues were safety concerns (40%), budget constraints (25%), and environmental impacts (20%). A smaller portion (15%) mentioned regulatory and political issues as potential barriers. These insights are summarized in Table 9.

Table 9. Key challenges in developing the railway right-of-way

Development Challenge	Percentage of Respondents
Safety concerns	40%
Budget constraints	25%
Environmental impacts	20%
Regulatory or political factors	15%

Development Preferences: When asked about the types of development that would be most beneficial to the community, stakeholders supported a balanced approach that integrates recreational parks (35%), walking and cycling paths (30%), and urban green spaces (25%). A smaller portion of respondents also advocated for commercial developments (10%), recognizing the economic potential of the space (see Table 10).

Table 10. Stakeholders' preferred types of development

Development Type	Percentage of Respondents
Recreational parks	35%
Walking and cycling paths	30%
Urban green spaces	25%
Commercial developments	10%

Partnerships for Implementation: Stakeholders emphasized the importance of public-private partnerships (40%) in ensuring the successful implementation of the project. Additionally, 30% advocated for engaging local community groups, while 20% stressed the role of non-governmental organizations (NGOs). A smaller group (10%) believed international funding bodies could provide necessary financial support (see Table 11).

Table 11. Preferred partnerships for project implementation

Partnership Type	Percentage of Respondents
Public-private partnerships	40%
Local community groups	30%
Non-governmental organizations	20%
International funding bodies	10%

In conclusion, stakeholders identified a mix of technical, financial, and operational challenges that need to be addressed

for the successful development of the railway right-of-way. They also provided clear guidance on the types of partnerships and development models that would best align with the community’s needs and the railway’s operational requirements.

4.3 Factor analysis results

4.3.1 Factor analysis results

To analyze the key themes influencing residents’ preferences regarding the development of the railway right-of-way in Dora, a factor analysis was performed. The analysis extracted three primary factors that explain a significant portion of the variance in the data. These factors represent the main dimensions of residents’ concerns, preferences, and demographic influences.

4.3.2 Interpretation of factors

Factor 1: Age-related preferences

The first factor, showing high loadings on age, reflects that respondents’ preferences are significantly influenced by their age group. This factor suggests that older residents (46+) show a greater preference for quieter, passive spaces such as green parks, whereas younger respondents (18-30) lean toward more active recreational spaces like cycling and walking paths.

For example, the high loading on age (loading = 0.85) indicates that older age groups prioritize tranquility and natural aesthetics, while younger respondents are more concerned with accessibility and recreational facilities. These insights suggest a potential need to cater to both groups by designing spaces that offer diverse uses, such as quiet zones as well as active recreation areas.

Factor 2: Concerns about safety and maintenance

This factor, with the highest loadings on safety concerns and noise from trains, highlights that the operational aspects of the railway significantly affect the community’s acceptance of the proposed developments. For instance, residents who expressed concerns about the proximity of active railways and noise levels (loading = 0.72) were less enthusiastic about the development.

Table 1 illustrates that concerns about safety are most pronounced among families with children, who prioritize safe pedestrian crossings and barriers to mitigate potential risks. The results suggest the importance of integrating safety measures such as physical barriers and noise-reducing technologies in the development plans.

Factor 3: Current usage of the railway area

The third factor reflects how current usage of the railway right-of-way shapes development preferences. Respondents who primarily use the area for commuting (loading = -0.81) are less concerned with recreational developments, while those who view the space as underutilized for recreational purposes expressed stronger support for green spaces and parks.

For instance, residents who currently use the railway right-of-way for walking or cycling favored expanding these areas, while commuters were more focused on practical improvements such as improved transport links. This suggests that the development plan should balance the needs of recreational users and commuters by incorporating both green pathways and functional infrastructure (see Table 12, Figure 6).

The factor analysis highlights the factors that most influence the formation of residents’ attitudes towards the development of the railway corridor, with safety, social interaction, and

accessibility emerging as the most important influences. These findings reinforce the need to design a project that meets community expectations and strikes a balance between operational and environmental aspects.

Table 12. Summary of factor loadings

Variable	Factor 1: Age Preferences	Factor 2: Safety Concerns	Factor 3: Current Usage
Age	0.85	-0.02	0.04
Safety concerns	0.12	0.72	0.15
Noise from trains	-0.05	0.72	0.12
Recreational preferences (cycling, parks)	0.33	0.02	0.61
Commuting use of railway space	-0.02	-0.81	0.81

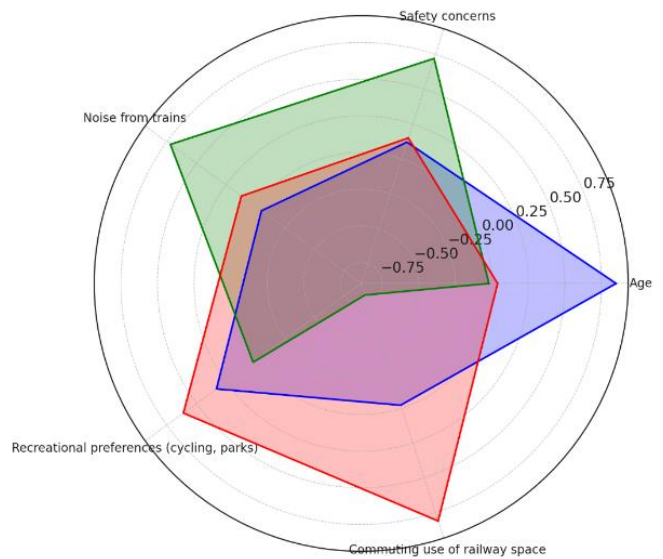


Figure 6. Factor interpretation and insights

4.4 Summary of factor loadings

Each factor provides critical insights into how demographic characteristics, safety concerns, and current usage influence development preferences. The results underscore the need to:

- 1. **Cater to age-based preferences** by offering both passive and active recreational spaces.
- 2. **Address safety concerns** through robust safety measures, especially in areas adjacent to the active railway lines.
- 3. **Balance the current and potential uses** of the railway area, ensuring that the development serves both commuters and recreational users.

5. DISCUSSION

5.1 Interpretation of findings

The results of this study are import for the needs and requirement of the local community and stakeholder analysis about the development of railway right-of-way in the Municipality of Dora. They identified three important dimensions that drive these preferences: age-related

preferences (older users preferring cheaper models due to lower annual average costs), safety and operational concerns (newer technology not being adopted right away), and current usage but possibly leading into future development expectations (realising that the automation will likely not be the first model).

The first factor, age-related preferences, demonstrates the very different needs between demographic groups. Older residents tended to prefer quiet, passive space in the form of parks, while younger residents preferred more active recreational facilities like walking and cycling paths. This finding is consistent with existing literature, which indicates that urban green spaces should serve different age groups to remain utilitarian and relevant across the population. Hence, both passive and active areas integrated together in the right proportion will be key to the success of the project.

The second factor that stood out was that of safety and integrity/safety. Respondents, including families and those living with small children, raised concerns about the active status of the railway and noise pollution, as well as living close to tracks. Strong safety measures — like physical barriers, noise-reducing technologies and safe pedestrian crossings — were urged. This result, however, stems from worldwide patterns of redevelopment of urban railways, as demonstrated through various implementations around the world (i.e., Sydney Light Railway right-of-way between Central and Circular Quay, and the Yamanote Line in Tokyo) which has also proven to be beneficial through strategic and beneficial decisions taken towards operational safety and community engagement. Respond to these challengers to ensure community acceptance and sustainability.

The third factor, current usage and development expectations, shows how residents preferences about future development of the railway area are influenced by current use of it. Regular commuters wanted practical improvements, especially transport links, while residents who see the area as underutilized focused on green and recreational developments. This duality underscores the necessity for an all-inclusive development plan that balances pithy functional infrastructure with more recreational activities, so that the spaces accommodate both its practical current needs, as well as future aspirations.

5.2 Implications for urban planning

Such significant outcomes align with the long-standing need for reconsideration of urban formation in Dora and across other urban areas. Representing strong support for green spaces (over 70 percent of respondents said they were "very important"), the first chart serves as a clear directive to urban planners about the integration of sustainable green infrastructure. This will ensure that there are parks and community gardens and walking paths as recreational needs, but it will also be part of environmental sustainability and community well-being. These features integration will encourage active transportation, in line with the city goals in the domain of urban mobility.

Second, the focus on safety means planners must balance the operational limitations of the railway against the need for public space design. Installing safety barriers, controlled pedestrian crossings, and soundproofing measures are effective measures to minimize the risks of railways while keeping rail functionality intact." Making sure these safety

considerations are included in the totality of planning will be critical to garnering both stakeholder and community support.

Lastly, the results underscore the importance of engaging a variety of stakeholders (urban planners, environmental authorities, transportation agencies, etc.) in the planning and implementation phases of the project. In addition, the results clearly show that a public-private partnership for construction and maintenance of the project, along with community participation in its sustainability, is preferred. This collaborative, multidisciplinary approach will help to balance technical, financial, and social factors.

5.3 Challenges and limitations

Although the study provides important findings, there are a number of challenges to consider. Operational constraints of the railway present significant challenges for the development of adjoining recreational spaces. This is a delicate balance that needs to be handled wisely — ensuring safety, especially for families. Also, budget can be a challenge according to stakeholders and may restrict the size or scope of the development. The implementation of international treaties does not take place in a vacuum and regulatory and political factors could also prove complicating, especially given ongoing infrastructure needs in Iraq.

In addition, environmental effects also cannot be ignored. When developing green spaces, it is vital to consider the ecological balance of the area and include sustainable technologies, for instance, drought-resistant plants and water-efficient irrigation systems. International case studies, such as the focus on our essay on the Finland Railway Line in Saint Petersburg, could serve for examples to draw lessons from regarding the intersection between green technologies in the infrastructure and operations.

5.4 Comparison of factor analysis results with previous research

The results of the factor analysis in this study are consistent with many previous research on the development of railway corridors and urban spaces. For example, similar studies in Australia and India have shown that safety and green spaces are key factors influencing residents' acceptance of railway rehabilitation projects.

However, this study differs from some international research in some aspects, as studies in Japan and Europe have shown that economic factors such as attracting private investment play a greater role in the acceptance of these projects. In contrast, in the context of Dora Municipality, the safety factor was the most influential, reflecting local challenges associated with infrastructure and transportation in Iraq.

These findings underscore the importance of adapting development strategies to local conditions, as global solutions cannot be applied directly without taking into account socio-economic factors in each context.

5.5 Recommendations

5.5.1 Implementation of appropriate safety measures around active railway lines

- To ensure public safety, durable and tamper-resistant barriers should be installed along the edges of spaces adjacent to active railway lines to prevent

unauthorized access. These barriers must meet international safety standards for railway environments while also considering local conditions.

- Pedestrian walkways and cycling paths should be designed to maintain maximum possible distance from active railway lines. These paths must include well-marked and secure crossing points with light and sound alerts to warn of approaching trains, reducing the risk of accidents.
- Noise-reducing walls should be installed near residential areas most affected by train noise. These walls can be integrated into the green infrastructure, enhancing the aesthetic appeal while mitigating noise pollution.
- A continuous safety monitoring system should be implemented using surveillance cameras and sensors to detect potential risks, such as children or animals approaching the tracks.

5.5.2 Comprehensive and sustainable maintenance plan

- A detailed maintenance plan should be established that includes regular cleaning of green spaces, maintenance of barriers, and upkeep of public amenities such as benches and lighting poles. It is essential to designate responsible entities, whether governmental agencies or contracted private firms.
- To ensure the long-term sustainability of the project, a portion of the city's annual budget should be allocated for the ongoing maintenance of green spaces and infrastructure. Public-private partnerships (PPP) can be leveraged to share the financial burden.
- Consider adopting remote sensing technologies to monitor infrastructure wear and tear or detect issues before they worsen. Moisture sensors can be used to monitor irrigation needs, ensuring that green spaces are properly maintained without overusing water.

5.5.3 Enhancement of green spaces considering environmental and climatic conditions

- Due to Baghdad's hot and dry climate, plants that require minimal water and can withstand high temperatures should be chosen. Native plants, such as palms and drought-resistant shrubs, will ensure the sustainability of the green spaces.
- To optimize water usage, drip irrigation systems or

smart irrigation controlled by soil moisture sensors should be installed. These systems will minimize water waste and ensure that plants receive the care they need without over-irrigation.

- To promote environmental sustainability, the green spaces should be connected with other green corridors in the city, such as public parks and open spaces, providing continuous ecological pathways and enhancing urban biodiversity.

5.5.4 Public-private partnerships for sustainable financing

- To ensure the financial sustainability of the project, public-private partnerships should be encouraged. Private companies can invest in creating and maintaining green spaces and facilities in exchange for advertising rights or commercial use of certain areas (such as eco-friendly cafes or restaurants).
- The local community can be encouraged to participate in maintaining the green spaces by forming local associations responsible for organizing recreational and social activities in the area. This approach will enhance the sense of ownership and responsibility among residents.

5.5.5 Financial and operational sustainability

- The project could benefit from international grants and aid offered by global environmental organizations to support environmental sustainability and mitigate climate change. Collaborating with international institutions focused on sustainable development can secure the funding needed for key aspects of the project.
- Small commercial facilities, such as eco-friendly cafes or kiosks, can be integrated into the project to generate revenue that can help fund maintenance and operational costs of the green spaces.

5.5.6 Continuous monitoring and evaluation

- A mechanism should be established for periodic evaluation of the project's performance and its achievement of environmental and recreational goals, including community satisfaction and the effectiveness of safety and maintenance measures. This can be achieved through annual surveys or public hearings with local residents.

Table 13. Project phases and timeline

Phase	Timeline	Key Actions	Stakeholders Involved
Phase 1: Planning	6-9 months	- Conduct detailed feasibility studies - Finalize designs with input from local residents and stakeholders - Secure necessary permits	Municipality of Dora, Urban Planners
Phase 2: Pilot Projects	9-12 months	- Implement pilot green spaces and pedestrian pathways - Monitor public response and usage - Collect data on safety and maintenance	Municipality, Environmental Officers
Phase 3: Infrastructure	12-24 months	- Begin construction of larger infrastructure such as cycling paths, parks, and seating areas - Integrate noise reduction and safety barriers	Public-Private Partnerships (PPPs), Contractors
Phase 4: Community Engagement	Ongoing	- Conduct workshops and events to educate the public about the spaces - Involve local groups in maintenance and activities - Establish maintenance protocols	Local Community Groups, NGOs
Phase 5: Long-Term Sustainability	24-36 months	- Secure long-term funding for space upkeep through public-private partnerships - Evaluate environmental impact	Municipality, NGOs, Local Businesses

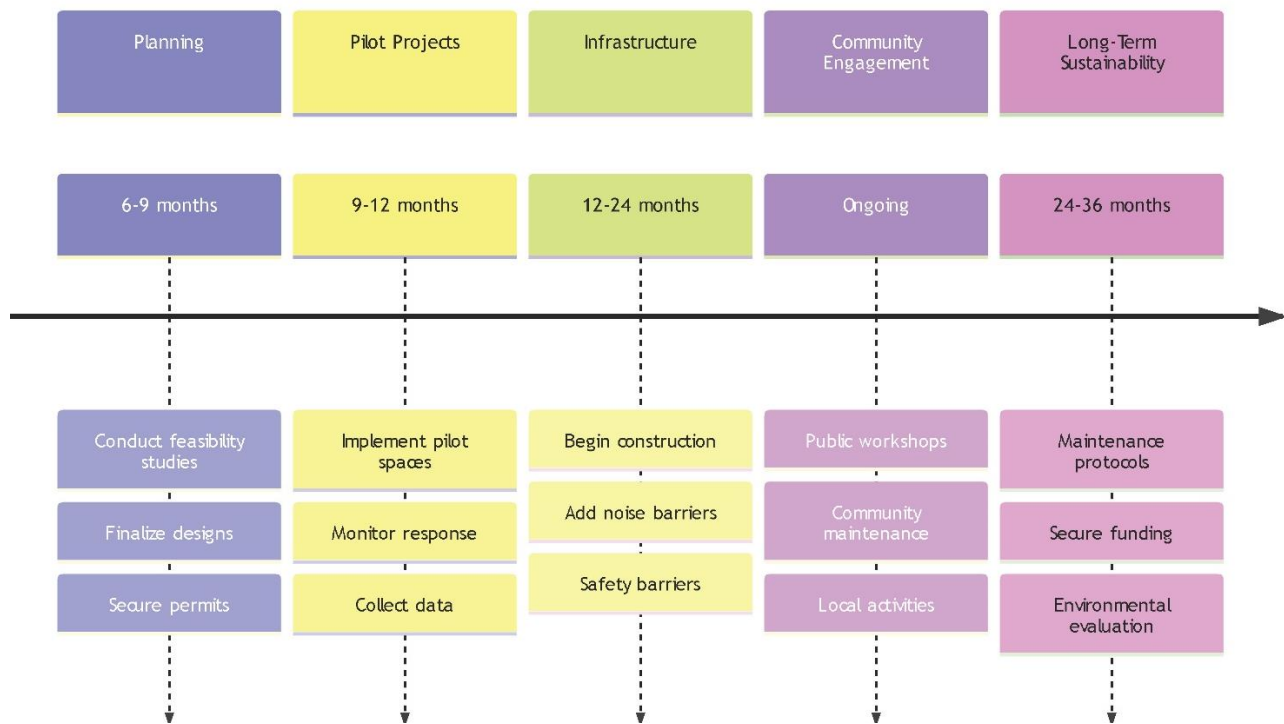


Figure 7. Project implementation flowchart

- Based on the results of evaluations, there should be flexibility in making necessary adjustments to the project, such as changing plant types or modifying pedestrian and cycling paths to better suit the evolving needs of the population.

5.5.7 Proposed implementation roadmap

To ensure the successful transformation of the railway right-of-way in the Municipality of Dora, the following roadmap outlines the key phases and steps involved in implementing the recommendations (Table 13, Figure 7).

The table shows the proposed time phases for the implementation of the project, which helps to assess the extent to which it can be achieved according to the available resources. It also highlights the need for effective management to ensure that each phase is implemented within the specified time frame without delay.

This roadmap ensures that the project progresses in manageable phases, balancing the technical, financial, and community-related aspects of the development.

6. CONCLUSION

6.1 Summary of key findings

The design project successfully examined the possibility of converting the railway right-of-way in the Municipality of Dora into pad a multi-purpose space capable of serving both environmental and recreational roles. Results show that there is great community interest in using this otherwise underused space to create green spaces, walking and biking paths, and community gardens. Such developments were shown to be desirable for many of the residents, alluding to the need for more recreational spaces in a neighbourhood context, and the environmental and quality of life benefits that come with incorporating these spaces.

The factor analysis presented three major themes impacting community preferences: age-associated preferences, safety and operational issues, and current usage aligning with anticipated development. The results emphasised the importance of an inclusive model of urban development which would need to take into consideration the diversity of needs experienced by urban groups. Older residents leaned toward passive space, like parks, while younger people leaned toward active recreational facilities. Operational and safety concerns linked to the active railway were also paramount, with families voicing specific concerns about noise, safety barriers and pedestrian crossings.

The study also found that there is a duality in how the area is currently used. Residents, who used the space for daily commuting more interested in practical developments in infrastructure and facilities, whereas others who viewed these areas as pure under-utilisation were keen on recreational development.

6.2 Contributions to knowledge

The resulting urban planning implications add to the broader literature on the opportunities and challenges of repurposing active railway right-of-ways into multi-function spaces compatible with both their present and future operational functions. The research highlights community preferences while overcoming technical challenges, providing a practical roadmap for similar urban development. This study is especially significant for cities in developing countries, as reconciling infrastructure requirements and the desires of localities has the potential to enhance urban livability markedly.

The study reveals stakeholders' points of view—including potential economic aspects, safety considerations, and environmental consequences—and offers significance for public-private partnerships as well as for the inclusion of sustainable technologies. The findings offer a blueprint for

urban planners of the future and help design spaces that meet recreational and environmental needs, but also maintain the operational integrity of key transport infrastructures.

6.3 Future research directions

While this study provides valuable insights, several areas require further exploration. Future research could expand on this work by examining similar projects in other urban contexts where active railways are present, with a focus on geographic and socio-economic variations. Additionally, long-term studies on the sustainability of these spaces—particularly their impact on public health, urban mobility patterns, and environmental outcomes—would further enhance understanding.

Further exploration of community participation models in the planning and maintenance of such spaces would also be beneficial, particularly in developing localized strategies for ensuring the long-term success of these projects. Comparative studies across different regions and cultural contexts could refine best practices for transforming railway corridors into sustainable public spaces globally.

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