Ritam Samanta

Reconnecting Urban Spaces: A Strategic Approach to Tramways through Heritage Route Mapping (A Case of Kolkata)

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Master of Planning
(Transport Planning and Logistics Management)

Ritam Samanta
[2022MTPLM008]

SCHOOL OF PLANNING AND ARCHITECTURE, BHOPAL
NEELBAD ROAD, BHAURI, BHOPAL (MP)-462030

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Thesis submitted in partial fulfillment of the requirements for the award of the degree of

Master of Planning
(Transport Planning and Logistics Management)

By
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Scholar No. 2022MTPLM008

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May 2024

Declaration

I **Ritam Samanta**, Scholar No. **2022MTPLM008** hereby declare that the thesis titled **"Reconnecting Urban Spaces: A Strategic Approach to Tramways through Heritage Route Mapping (A Case of Kolkata)"** submitted by me in partial fulfilment for the award of **Master of Planning**, at School of Planning and Architecture, Bhopal, India, is a record of Bonafide work carried out by me. The matter/result embodied in this thesis has not been submitted to any other University or Institute for the award of any degree or diploma.

Signature of the Student

Date: _____

Certificate

This is to certify that the declaration of **Ritam Samanta** is true to the best of my knowledge and that the student has worked under my guidance in preparing this thesis.

RECOMMENDED

_____

Signature of the Guide
Dr. Mayank Dubey

ACCEPTED

_____

Dr. Saurabh Popli
Head, Department of Transport Planning

May 2024

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Abstract

With roots in 1873, Kolkata is home to Asia's only surviving tram system, an iconic form of transportation. The tramway, which will commemorate its 150th anniversary in 2023, is a cost-effective, environmentally friendly, and secure mode of public transportation and a representation of the city's history. But even with their modest infrastructure and historical value, Kolkata's tramways are in danger of disappearing due to several pressing issues. To protect the sole tramway network on the continent, it is imperative that this essential legacy in transportation be revived. Nowadays, trams are seeing a resurgence all over the world. In the 21st century, 108 new towns introduced trams, mostly because of their pollution-free operation. Kolkata's tramway infrastructure still exists; by modernizing the system, it can be utilized to bring back the service. There are three active routes now, compared to six operational routes with a total track length of 39.37 kilometres prior to the pandemic.

Despite having 37 initial Tram routes, Kolkata has now only 3 operational routes and those routes are also degrading with time. Older infrastructures, less speed, probe to traffic congestions, poor maintenance are some of the primary reasons that citizens in Kolkata are preferring other modes of Public Transport (Buses, Metros, Autos etc.). The daily ridership number has been rapidly decreasing (from 1.6 lakh passengers per day in 2008 to merely 15000 passengers per day, as of 2022).

The 21st century is seeing unparalleled global climate change, necessitating the implementation of environmentally responsible solutions. India's energy sector emits a large amount of greenhouse gases into the atmosphere. 142 million tonnes of carbon dioxide emissions are produced each year, of which 123 million tonnes are produced by the transport sector alone. With these considerations in mind, India has committed to decreasing its carbon emissions by one billion tonnes by the year 2030, which will result in a 45% reduction in carbon emissions and the achievement of net-zero emissions by the year 2070. These pledges centre on the necessity of electric mobility, with Kolkata's century-old trams offering a practical choice for public transportation.

Trams are a more sustainable form of transportation than buses since they can carry more people and require less upkeep and operating. On the negative side, issues hindering the expansion of tramways include traffic jams on the roads, inadequate networks, passenger safety during boarding and alighting, and unsightly overhead wires. A well-designed tramway system will improve Kolkata's urban environment, leisure options, and tourism sector while also encouraging more people to utilize trams.

Other countries in Europe and Australia are concentrating on reviving their Tram network into Modern and convenient Light Rail Transits (LRTs) which offer a sustainable planning approach in transportation. In Kolkata’s context, both heritage and modern and sustainable development is needed for reviving the Tramways.

The thesis seeks to preserve Kolkata's architectural history while reestablishing urban areas with a tram network that is efficient for public transportation. The study aims to determine the cause of tram route closures, assess the current state and issues with the tram routes, and find and suggest solutions to make tramways a vital part of Kolkata's public transportation network while preserving its historical significance. The study's recommendations could serve as a model for creating and reinstating tramways in other Indian cities, however it is only focused on the Kolkata Municipal Corporation area.

The research has been focused to propose a planning framework, by integrating Heritage Route Mapping and developing modern infrastructure for passenger’s convenience. The Heritage Tram routes can be an integral part of the city by providing a chance to experience the City's heritage to the tourists. AHP method has been used to identify suitable Heritage sites and routes for tourism. Besides, the modern infrastructure has been proposed to cater daily passengers along with other modes of transport in the city.

Keywords – Tramways, Urban Spaces, Heritage Route Mapping, LRT, Grey Relational Analysis, RSM, WSM

सारांश

प्रारंभ से 1873 में शुरू होकर, कोलकाता एशिया के एकमात्र बचे हुए ट्रैम सिस्टम के घर के रूप में है, जो कि ट्रांसपोर्टेशन के ऐतिहासिक एक आदर्श रूप है। ट्रैमवे, जो 2023 में अपने 150वें जन्मदिन को याद करेगी, एक लागत-प्रभावी, पर्यावरण मित्र, और सुरक्षित जनसारणी का एक प्रतीक है। लेकिन अपनी साधारण बुनियाद और ऐतिहासिक मूल्य के बावजूद, कोलकाता की ट्रैमवे कई दबावपूर्ण मुद्दों के कारण लापता हो रही है। कोंटिनेंट पर एकमात्र ट्रैमवे नेटवर्क को संरक्षित करने के लिए, यह आवश्यक है कि इस महत्वपूर्ण परिवार को ट्रांसपोर्टेशन में दोबारा आजीवित किया जाए। आज कल, ट्रैम को पूरी दुनिया में फिर से उजागर हो रहा है। 21वीं सदी में, 108 नए शहरों ने ट्रैम लाया, ज्यादातर इसलिए कि उनका प्रदूषण-मुक्त ऑपरेशन होता है। कोलकाता की ट्रैमवे इंफ्रास्ट्रक्चर अब भी मौजूद है; इसे समर्थन के लिए अपडेट करके सेवा को वापस लाया जा सकता है। अब, तीन सक्रिय मार्ग हैं, जिसकी तुलना में प्री-पैंडमिक के दौरान 39.37 किलोमीटर की कुल ट्रैक लंबाई और 6 परिचालन मार्ग थे।

37 प्रारंभिक ट्रैम मार्गों के बावजूद, कोलकाता में अब केवल 3 परिचालन मार्ग हैं और उन मार्गों की स्थिति समय के साथ खराब होती जा रही है। पुराने इंफ्रास्ट्रक्चर, कम गति, ट्रैफिक जाम, नकारात्मक रूप से समर्थन, और गंदी रखरखाव जैसे मुख्य कारण हैं जिनके कारण कोलकाता के नागरिक अन्य सार्वजनिक परिवहन के माध्यमों को पसंद कर रहे हैं (बसें, मेट्रो, ऑटो आदि)। दैनिक सवारी की संख्या कम हो रही है (2008 में 1.6 लाख यात्री प्रति दिन से केवल 2022 के रूप में 15000 यात्री प्रति दिन तक)।

21वीं सदी में अद्वितीय वैश्विक जलवायु परिवर्तन को देखते हुए, पर्यावरणीय उत्तरदायी समाधानों की क़ायमीकरण की आवश्यकता है। भारत के ऊर्जा क्षेत्र से वायुमंडलीय गैसों की बड़ी मात्रा निकाली जाती है। हर साल 142 मिलियन टन कार्बन डाइऑक्साइड उत्सर्जित होता है, जिसमें से 123 मिलियन टन केवल परिवहन क्षेत्र द्वारा उत्सर्जित होते हैं। इन विचारों के साथ, भारत ने 2030

तक अपनी कार्बन उत्सर्जन को एक अरब टन कम करने का संकल्प लिया है, जिससे 45% कार्बन उत्सर्जन कम होगा और 2070 तक नेट-शून्य उत्सर्जन होगा। ये वादे विद्युत चालित मौबिलिटी की आवश्यकता पर केंद्रित हैं, जिसमें कोलकाता के सैकड़ों साल पुरानी ट्रैमों को एक व्यावसायिक विकल्प के रूप में एक प्राकृतिक चयन के रूप में प्रयोग करने की संभावना है।

ट्रैम बसों के मुकाबले पर्यावरण के प्रतिध्वनित ट्रांसपोर्टेशन का एक अधिक सतत रूप है क्योंकि वे अधिक लोगों को समर्थित कर सकते हैं और कम रखरखाव और ऑपरेटिंग की आवश्यकता होती है। नकारात्मक पक्ष के रूप में, ट्रैमवे के विस्तार को रोकने में आने वाली समस्याओं में सड़कों पर ट्रैफिक जाम, अपर्याप्त नेटवर्क, सफर के दौरान यात्रियों की सुरक्षा, और अनगरीब ओवरहेड तारें शामिल हैं। एक अच्छे डिज़ाइन की गई ट्रैमवे प्रणाली कोलकाता के शहरी वातावरण, अंतरंग विकल्पों, और पर्यटन क्षेत्र को सुधारेगी, जबकि यह अधिक लोगों को ट्रैम का उपयोग करने के लिए प्रोत्साहित करेगी। यूरोप और ऑस्ट्रेलिया में अन्य देश ट्रैम नेटवर्क को मॉडर्न और सुविधाजनक लाइट रेल ट्रांजिट्स (LRTs) में बदलने पर ध्यान केंद्रित कर रहे हैं जो परिवहन में एक सतत योजना का उपाय प्रदान करते हैं। कोलकाता के संदर्भ में, इतिहास और आधुनिक और पर्यावरणीय विकास दोनों की आवश्यकता है ट्रैमवे को पुनर्जीवित करने के लिए।

थीसिस का उद्देश्य कोलकाता के वास्तुकला इतिहास को संरक्षित रखने के साथ एक ट्रैम नेटवर्क को पुनर्स्थापित करना है जो सार्वजनिक परिवहन के लिए प्रभावी है। इस अध्ययन का उद्देश्य ट्रैम मार्ग बंद करने के कारणों का निर्धारण करना, वर्तमान स्थिति और ट्रैम मार्गों की समस्याओं का मूल्यांकन करना, और कोलकाता के सार्वजनिक परिवहन नेटवर्क के लिए ट्रैमवे को महत्वपूर्ण बनाने के समाधानों को खोजना और सुझाव देना है जो इसके ऐतिहासिक महत्व को बनाए रखते हुए हैं। इस अध्ययन के सिफारिशें अन्य भारतीय शहरों में ट्रैमवे बनाने और पुनर्स्थापित करने के मॉडल के रूप में काम आ सकती हैं, हालांकि यह केवल कोलकाता म्युनिसिपल कारपोरेशन क्षेत्र पर केंद्रित है। अनुसंधान में एक योजना की संकल्पना के लिए केंद्रित है, जिसमें विरासत रूट मैपिंग और यात्रियों की सुविधा के लिए आधुनिक बुनियादी बनावट को एकत्रित किया गया है। विरासत

ट्रैम रूट यात्रियों के लिए शहर की विरासत का अनुभव करने का मौका प्रदान कर सकते हैं। AHP विधि का उपयोग पर्यटन के लिए उपयुक्त विरासत स्थलों और मार्गों की पहचान करने के लिए किया गया है। साथ ही, यह आधुनिक बुनियादी बनावट की प्रस्तावना करता है जो शहर में दैनिक यात्रियों को विभिन्न परिवहन के माध्यमों के साथ खत्म करता है।

Table of Contents

List of Tables

List of Figures

List of Maps

List of Abbreviations

1) ADB - Asian Development Bank
2) AHP - Analytical Hierarchy Process
3) AMRUT - Atal Mission for Rejuvenation and Urban Transformation
4) CTC - Calcutta Tramways Company
5) EBRD - European Bank for Reconstruction and Development
6) EDVs - Electric distribution vehicles
7) GRA - Grey Relational Analysis
8) HMC - Howrah Municipal Corporation
9) IFC - International Finance Corporation
10) ITS - Intelligent Transport System
11) KMC - Kolkata Municipal Corporation
12) KMPH - Kilometre per Hour
13) LRTS - Light Rail transport System
14) LRVs - Light Rail Vehicles
15) LOS - Level of Service
16) LULC - Land Use Land cover
17) MCDM - Multi -criteria decision-making techniques
18) MW - Mega Watt
19) POP - Proof-of-payment
20) PPP - Public Private Partnership
21) PSP - Public Semi-Public
22) ROW - Right-of-way
23) RSM - Rank Sum Method
24) SWOT - Strength Weakness Opportunity Threat
25) TSP - Transit-signal priority
26) TTC - Toronto Transit System
27) UITP - International Association of Public Transport
28) WBTC - West Bengal Transport Corporation
29) WSM - Weighted Sum Method

CHAPTER 1: INTRODUCTION

1.1 Background

In 1873, Kolkata's tramway system began functioning, and it continues to this day. With just 15,000 passengers on a daily average, it is the oldest public transit system still in operation. Being the only city in Eastern India, Kolkata has quickly become urbanized because of several reasons, including its location and historical significance as the capital of British India.

Kolkata's tramway system has been operating for more than a century and is now seen as an Integral component of the city. Seeing the shifts in authority and the efforts made to repair and maintain things is intriguing.

It is common knowledge that citizens and business executives tend to avoid Kolkata's historic district. So, the bulk of private and public businesses are moving some of their offices to locales that are relatively more recent. The transportation issue is the primary cause of this carelessness. Due to a significant increase in the population and the ownership of vehicles, the central Kolkata transportation system suffers from traffic congestion, low speed, and lengthy travel times.

Kolkata's transportation network combines traditional modes of transportation with contemporary mass rapid transit. People use high-speed, contemporary transit systems like the metro and high-speed buses here. Also, they use a slow, immature system like the Tramway system. Narrow road widths, outdated and undeveloped motorized and non-motorized vehicles, such as the Tramways System and human-pulled Rickshaws, are some important problems that may be to blame for the transportation problems in central Kolkata. This area's tram line contributes in several ways to the traffic congestion.

Being an eco-friendly, sustainable, and safest mode of public transit, Tramways in Kolkata needs better planning and implementation approach to uplift its use in the city for overall a better mode of transit. This research aims to develop an integrated planning approach with modern transportation technology as well as heritage conservation to revive the Tramways in ‘The City of Joy, Kolkata.

1.2 Need of the Topic

i. Even before other forms of transportation, trams were among the first public transportation options made available to the global community. Over time, they have done a good job of serving their role, moving from horse-drawn carriages to electric ones. Currently, there is a push to transition to environmentally friendly alternatives due to the world's unparalleled climate.

ii. Just the transport sector in India consumes 94 million tonnes of oil, or 18% of the nation's total energy requirements. (Goma Lhamu Tshering, 2021). The bulk of this energy requirement is supplied by imports of crude oil. Because of the instability of the world market right now, external influences might easily affect the domestic energy business. One sector alone, the transportation sector, accounts for 123 million of the 142 million carbon dioxide emissions that the energy industry produces annually. This adds significantly to the warming of the planet. Aiming to reduce its carbon footprint by one billion tonnes, India wants to attain net-zero emissions by 2070 and a 45% decrease in carbon emissions by 2030. Additionally, India has pledged that by 2030, 500GW of energy will be produced from non-fossil fuels and 50% of its overall energy needs will be met by renewable energy.

iii. These elements make it necessary to revive the tramways with their pre-existing infrastructure like tracks, depots, terminals, and labour force—so that the project may be completed more easily. Due to a decade of neglect, the tramways require a thorough analysis and practical solutions that will meet the demands of the city, protect its historical significance, and incorporate the tramways into the city's public transportation system.

iv. When compared with cost vs distance and cost vs time to other forms of transportation, trams are frequently the most economical choice, particularly for longer distances. They can be a more affordable option for commuters because they provide a set rate regardless of the distance. But when deciding which kind of transportation is best for a given trip, other important considerations like convenience, accessibility,

and service frequency all come into play. For an 8-kilometer journey, the most expensive tram fare is merely Rs. 7, compared to Rs. 15 for buses, Rs. 10 for metro, and Rs. 12 for autorickshaws. Moreover, the suburban train costs Rs. 5. (Figure 1)

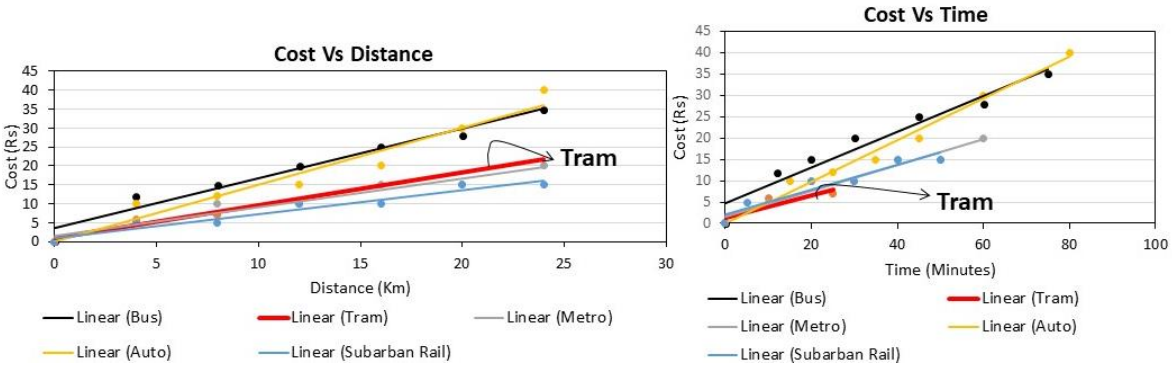


Figure 1: Comparison of Cost Vs Distance & Cost Vs Time
Source: *https://wbtc.co.in/ https://mtp.indianrailways.gov.in/*

1.3 Tram Around the World

The growth of the automobile sector caused a fall in the operating of tramways in the middle of the 20th century. Due to the socioeconomic circumstances in the world's largest cities, people started using private vehicles instead because they were quick and adaptable. But the twenty-first century has brought new challenges for humanity, including global warming brought on by a steady rise in greenhouse gas emissions, primarily from the conventional fuel-powered automotive sector. This has caused many tramways all over the world to reclaim their former standing in relation to urban public transportation. Nowadays, 389 cities throughout the world use light rail transit (LRT), the modern term for tramways.

As of 31st December 2018, Europe has tramways operating in 204 cities followed by 83 cities in Eurasia, 42 cities in Asia-Pacific, 40 cities in North America, 11 cities in Middle East and North Africa, 8 cities in South America and 1 city in Africa. (Rail Unit, 2019)

Figure 2: Tram in Zürich, Switzerland
Source: Consulting, 2019

Figure 3: Tram in Lyon, France
Source: Consulting, 2019

Recently, a comparative analysis was conducted on 32 tramways around the world based on ridership, multimodal integration, speed, pricing, and reliability. Two best-performing tramways were chosen in three categories namely, large cities, mid-sized cities, and cities with historic tram systems. Unsurprisingly, the country to have the first permanent tramways in the world still stands tall in serving as a model for tramways. Lyon and Paris (both cities in France) (Figure 2) tramways were adjudged as the best performing tramways in the category of large cities. Dijon and Tours (both cities in France) (Figure 3) tramways were adjudged as the best performing tramways in the category of mid-sized cities. Zürich and Vienna were adjudged the best performing tramways in the category of historic tramways. (Consulting, 2019)

1.4 Research Questions

i. What caused decline for Tram in Kolkata?
   a. Why the tram in Kolkata is declining day by day?
   b. What are the major points behind declining of tramways of Kolkata?
ii. What is the present role of Tram in Kolkata?
   a. How many tram routes are presently operational?
   b. What is the daily ridership of tram at present?
   c. What is the economic condition of tram?
iii. What are the alternatives of tram in Kolkata?
   a. Should the Tram operate in new routes?
   b. Should the Tram have been totally abolished?
   c. Should the Tram continue to run as is?
   d. Should the Tram operate in Zero Emission Zone?
   e. Should the Tram operate in Heritage route?

1.5 Aim

To explore the opportunities of tramway operation in context of both sustainability aspects and heritage considerations.

1.6 Objectives

The objectives of this research work are mentioned following:

i. To identify the reasons for the progressive degradation of Kolkata's tram system.
ii. To examine the existing conditions and problems of the tram routes.
iii. To analyse all attributes in order to conduct a Gap analysis of the system that needs improvements.
iv. To propose Planning Framework for KMC area by Integration of Heritage Route Mapping.

1.7 Scope

i. The research will focus on developing existing tram routes to a modern, accessible, and convenient mode of Public Transport.
ii. The research will redevelop heritage tourism in the city by integrating Heritage tram routes and generate revenue for the authority.
iii. The research will develop sustainable mode of transportation system in the city.

1.8 Limitation

i. The study area is limited to Kolkata Municipal Corporation (KMC) area.
ii. Study is based on limited secondary data made available by West Bengal Transport Corporation (WBTC).

1.9 Methodology

The study will be carried out in various stages. First, the topic is identified through detailed research of Kolkata tramways. The need of the study is determined to carry it forward. This led to the streamlining of the research area by formulating research questions by identifying the research gaps. This helps in developing the aim and objectives of the study. The scope and limitations of the study is also considered at this point.

Objective one was to identify the reason of tram route closures which was done through a preliminary site study which was conducted through reconnaissance and photographic surveys and interviews with various stakeholders such as tram users, employees of WBTC and people residing or working beside tram routes. Objective two involved the data collection which was done by primary survey based on user survey (questionnaires). Analysis was conducted based on these data which involved making a comparative cost analysis of tram, bus and auto; vehicular speeds and right of way of road stretches; observing and mapping road infrastructure along tram routes; observing and mapping heritage and tourist places, educational institutions, commercial centres and land use along existing tram routes to understand the purpose of travel, understanding user perception through graphs and pie charts and inferences from stakeholder discussions.

The schematic diagram of the methodology is shown below (Figure 4):

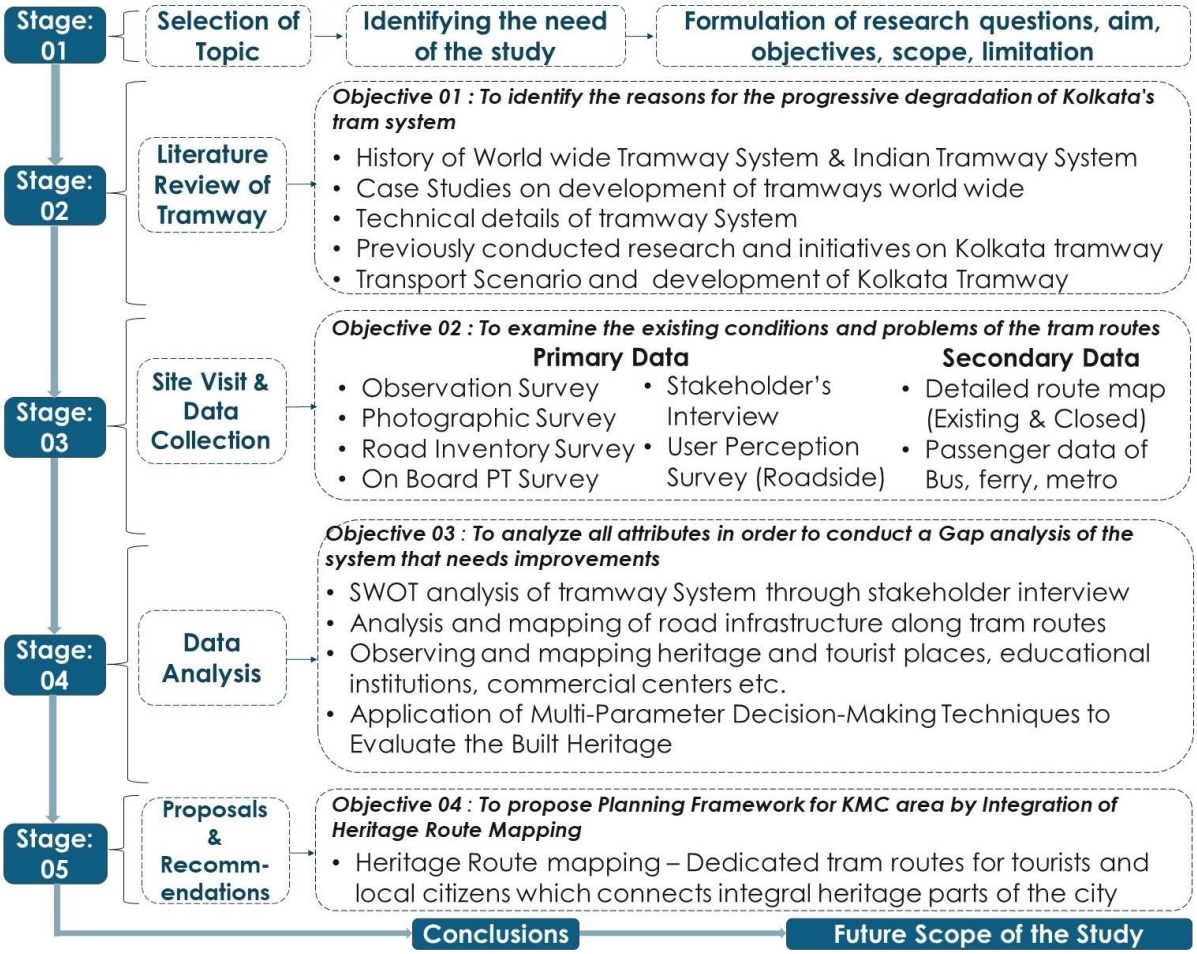


Figure 4: Methodology
Source: Author Generated

CHAPTER 2: LITERATURE REVIEW

2.1 Trams – An Overview

Tramways, also known as streetcars or trolleys, are a form of public transportation that run on rails embedded in the street or on a dedicated track. Tramways are typically powered by overhead electric wires or an on-board battery, and they often operate in urban or suburban areas. Tramways were first introduced in the 19th century and quickly became a popular mode of transportation in cities around the world. Today, tramways are found in many cities and are often seen as a more environmentally friendly alternative to buses or cars. Tramways can be single or double decker, and they can run on their own dedicated tracks or share the road with other vehicles. They typically stop at designated stations along their route and often have a fare system like buses or trains.

2.2 History of trams – Indian Context

Other cities in India soon follows Kolkata's lead with tram network were established in Bombay (Mumbai) in 1874, Madras (Chennai) in 1895 and Delhi in 1908. But in present days, all the tram networks are closed in most of the cities except Kolkata (Table 1). The Calcutta Tramways Company (CTC) was established in 1880, and it is still one of the oldest operating tram networks in the world.

Table 1: Different cities in India with Tram Network duration

City	Opening Year	Closing Year
Kolkata	1873	Running
Mumbai	1874	1964
Nasik	1889	1933
Chennai	1895	1953
Kanpur	1907	1933
Kochi	1907	1963
Delhi	1908	1963
Bhavnagar	1926	1947

Source: Indian Journal of Spatial Science Autumn Issue 10(2) 2019 pp.59 – 64

2.3 History of trams – Kolkata Context

Kolkata has the only surviving Tram System in Asia, operating from 1873, also recognized as a heritage mode of Transport in the city. It is recognized as one of the most economic, sustainable, and safe mode of public transport in the city. Tram in Kolkata is facing various problems to sustain and it is declining day by day. The following describes Kolkata's entire tram timeline:

- 1873: The first tram debuted on Kolkata streets on 24th February, 1873 with the opening of a 3.9 kilometres track between Sealdah and Armenian Ghat.
- 1880: The formal opening of Kolkata trams took place with the formation and registration of The Calcutta Tramways Co. Ltd.
- 1881: New routes were opened connecting Dalhousie Square with Sealdah, Esplanade.
- 1882: New routes opened connecting Esplanade with Shyambazar.
- 1883: The famous route number 36 connecting Esplanade with Khidrpur was opened.
- 1884: New route connecting Wellington Square with Park Street was opened.
- 1900: New route connecting Nimtala to Companybagan was inaugurated.
- 1902: The Khidirpur and Kalighat lines were the first to be electrified with the first electric tramcar running between Esplanade and Khidirpur on 27th March, 1902.
- 1903: New routes connecting Shyambazar with Belgachhia and Kalighat with Tollygunge were opened. 1905: New routes connecting Howrah Bridge with Sealdah, Esplanade and Shyambazar were opened.
- 1907: New routes connecting Moulali with Nonapukur and Wattganj with Mominpur were opened. 1908: New routes connecting Shyambazar with Galiff Street, Howrah station with Bandhaghat and Shibpur and Hazra Park with Behala via old Majerhat bridge were opened.
- 1910: New routes connecting Rajabazar with Sealdah, Esplanade and High Court were opened.
- 1925: New route connecting Nonapukur to Park Circus was opened.

- 1928: New routes connecting Ballygunge with Kalighat, Tollygunge, Behala and Dalhousie Square were opened.
- 1941: New route connecting Rajabazar with Shyambazar was opened.
- 1943: The Kolkata tramway system was connected to the Howrah tramway system via the newly built Howrah Bridge. All trams running up to Howrah Bridge were now running up to Howrah station.
- 1967: The government of West Bengal enacted the Calcutta Tramways Company Act, 1967 which allowed the government to take over the management and operations of the tramways on 19th July, 1967.
- 1971: Route closures began as soon as the government of West Bengal took over the management of the tramways. The routes connecting Howrah station with Bandhaghat and Shibpur were closed.
- 1973: The route connecting Howrah Bridge to Company bagan was closed.
- 1978: The route connecting Esplanade with Hazra Park was closed for facilitating the construction of metro line. 1981: A new route connecting Purabi Cinema with Lebutala was opened. The Sealdah terminus was closed to facilitate the construction of the Sealdah flyover and trams were diverted via Purabi Cinema. At this same time, the route connecting Esplanade with Lalbazar was closed.
- 1986: The last extension of the Kolkata tramways took place with a new route connecting Behala to Joka being opened.
- 1992: The route connecting Esplanade with Planetarium was closed. The Calcutta Tramways Company also introduced bus service with an initial fleet of 40 buses on 4th November, 1992.
- 1994: The route connecting Metcalfe Hall to Howrah Bridge was closed.
- 1995: The route connecting Dalhousie Square with High Court was closed.
- 1998: The connection between Gariahat depot and Ballygunge junction was closed.
- 2002: The route connecting Mominpur with Behala was closed.
- 2004: The route connecting Shyambazar with Galiff Street was closed.
- 2008: All routes from Dalhousie Square were closed.
- 2011: The route connecting Behala with Joka was closed.

- 2012: All routes from Bag bazar and Galiff Street were closed.
- 2018: The route connecting Kalighat with Khidirpur was closed.
- 2019: The route connecting Maniktala with Belgachhia was closed. All routes via Sealdah flyover were closed.
- 2020: The iconic route connecting Khidirpur with Esplanade was closed due to damage caused by cyclone Amphan and metro terminal construction at Esplanade.
- 2022: All routes from Howrah Bridge have been suspended with only three remaining operational routes.

The following graphic illustrate the tram's periodic deterioration (Figure 5):

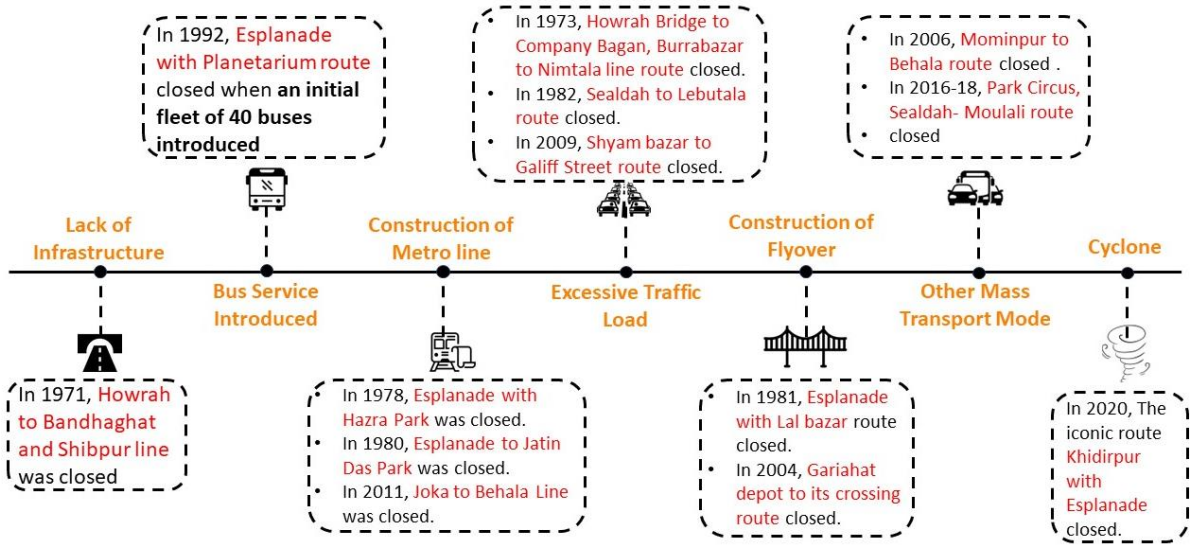


Figure 5: Periodic Deterioration of Tram
Source: https://wbtc.co.in/tram-service
DOI:10.15680/IJIRSET.2016.0505120

2.4 Present role of tram in Kolkata

Being a recognizable and traditional form of public transportation, trams are an important part of Kolkata's transportation network. They add to the distinct charm of the city and are highly appreciated for being reasonably priced, especially for short- to medium-distance trips. While renovation and growth have presented issues for Kolkata's tram network, attempts are being made to improve its efficiency and integrate it with other transportation options, like buses and the metro, to offer commuters a seamless and all-encompassing transit experience.

At its height, the Kolkata Tramway had 37 routes with a total track length of 70.74 km in 1969 (Figure 6). There are now only three routes in use in Kolkata, totalling

20 kilometres of track. From 1.6 lakh passengers daily in 2008 to just 15000 people daily as of 2022, the number of daily ridership has been falling quite quickly. Some of the main reasons Kolkata residents prefer other forms of public transport are older infrastructures, slower speeds, a lack of speed, traffic jams, and poor maintenance.

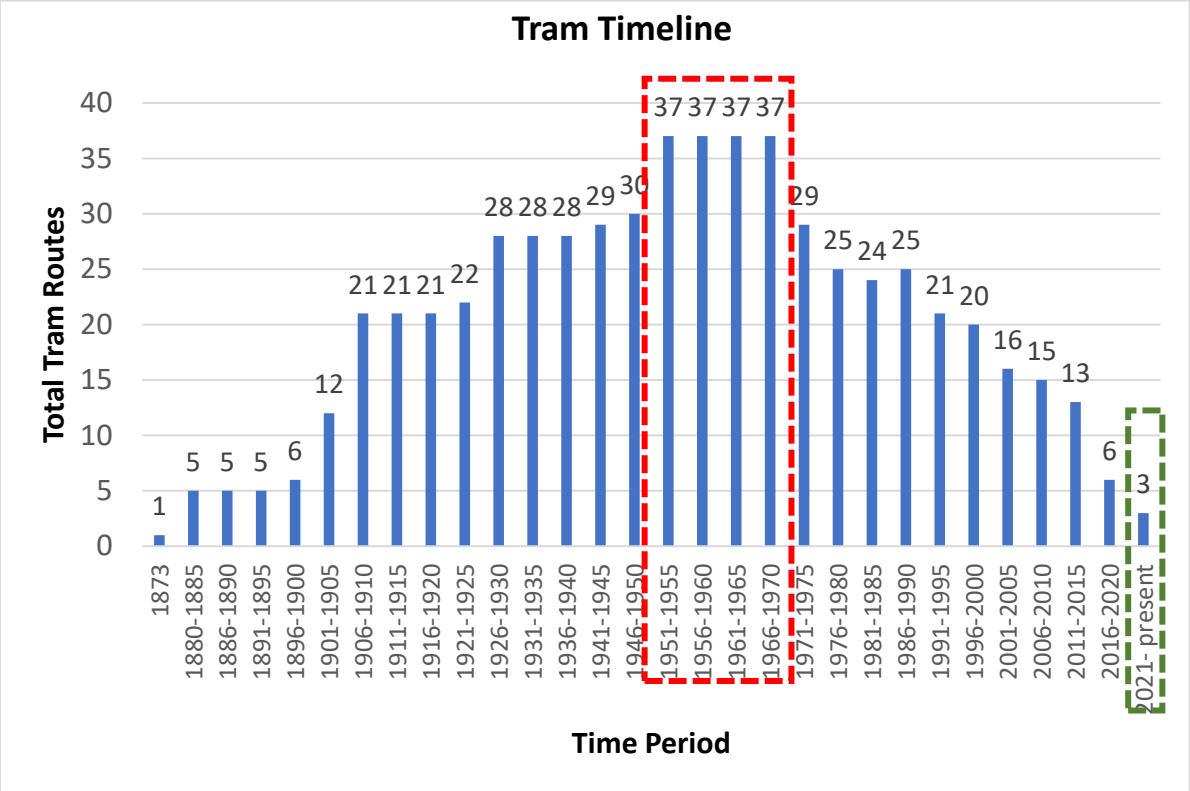


Figure 6: Tram Timeline

Source: https://wbtc.co.in/tram-service

The costs incurred in maintaining the tram service have been rising over time, while the revenue received from the service has not increased significantly. The tram service is currently facing a reduction in overall quality and operational standards because of the discrepancy between growing expenses and stagnating revenue. Deteriorating conditions and a lack of suitable care in its operations originate from the tramways' inability to maintain adequate levels of service due to insufficient revenue to cover the rising expenses. The severity of the financial mismatch and its effect on the tram service were highlighted by the fact that between 2007 and 2014, expenses were more than thirty times higher than income. (Figure 7)

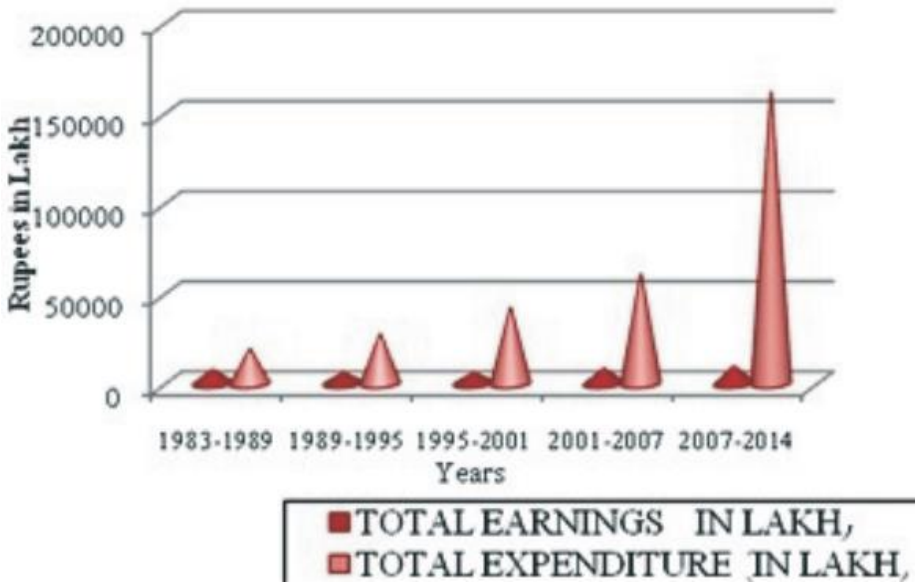


Figure 7: Income and Expenditure of Tram
Source: Indian Journal of Spatial Science Autumn Issue, 10(2) 2019 pp 59 - 64

2.5 Alternatives of tram in Kolkata

The main goals of Kolkata's alternatives to tramways are to improve public transportation's effectiveness and meet the city's changing mobility needs. The following are the tram's alternative options in Kolkata (Table 2):

i. **Closing of Tram routes -** A major change in Kolkata's transport environment would result from the decision to close the tram system. Despite their historical and cultural significance, tramways are not well suited to meet the demands of modern mobility because to their high operating costs and restricted capacity. The tram network would be shut down, freeing up space on the roads to possibly reduce traffic and improve flow. However, any choice would have to consider the effects on the current tram workforce, issues with history preservation, and the requirement for substitute transportation to cover the void left by trams.

ii. **Tram continues to run as is -** To keep the tram system operating as it is now, existing routes must be continued with little to no modification. This choice protects Kolkata's famous tram experience, which both residents and visitors love. To keep the system safe, dependable, and effective, however, constant investment in infrastructure upkeep, car updates, and operational improvements is also necessary. Maintaining the status quo could make it

more difficult for the system to adjust to shifting mobility trends and new transportation issues.

iii. **Operating Tram on Heritage Route -** The cultural significance and sentimental appeal of these iconic vehicles are highlighted by concentrating tram operations on heritage lines, such as those in Kolkata's ancient districts. By offering a distinctive travel experience and showcasing Kolkata's rich past, operating trams on heritage routes can draw heritage tourism. This strategy, meanwhile, would make the system less useful as a main form of mass transit, necessitating alternative modes of transportation for commuters who travel there daily. The successful implementation of this alternative depends on striking a balance between the protection of cultural assets and the demands of contemporary transportation.

iv. **Introducing new tram routes -** Trams can be added to new routes or extended to underserved areas to increase the system's accessibility and relevance. By extending the scope of tram services, this choice may draw in more customers and reduce transport demands in developing neighbourhoods. Nonetheless, to identify feasible routes and guarantee a smooth integration with current transportation networks, infrastructure investments, feasibility studies, and community involvement are required. Reviving the tram system and making the city more connected can be achieved by running it on new routes.

v. **Operating tram on Zero Emission zone -** Sustainable urban mobility can be enhanced by designating specific regions as net-zero emission zones, with access restricted to eco-friendly vehicles such as electric trams. Tram operations in these areas support international efforts to fight climate change and cut carbon emissions. To promote emission-free transportation, this approach necessitates investments in renewable energy sources, electric tram infrastructure, and legislative incentives. Running in net-zero emission zones not only lessens the impact on the environment but also establishes standards for environmentally friendly transportation in Kolkata.

One of the most important steps in assessing the different possibilities for the future of tramways in Kolkata is to create a matrix of comparisons using alternative choices for tramways (Figure 6). Prospective options include operating on new

routes, running on heritage routes, and focusing on net-zero emission zones—all of which are in line with current mobility trends and sustainability goals. To make an informed decision, one must, however, dig further into the opinions of stakeholders, technical viability, and long-term sustainability.

The matrix of comparisons that lists the advantages and disadvantages of each option offers an organized method for assessing alternatives; however, choosing the best option for tramways in Kolkata necessitates a thorough investigation that takes stakeholder input, technical viability, and long-term sustainability into account. This all-encompassing strategy guarantees that the selected solution fits the needs of the community, is in line with the goals of the city, and promotes sustainable urban mobility.

Table 2: Comparative Matrix of Alternative options for Tramway

Comparative Chart of Potential options for Tramway						
		Closing of Tram routes	Operating Tram as it is	Operating Tram on Heritage route	Introducing New Tram routes	Operating Tram on Zero Emission Zone
Pros	Reduce traffic Congestion	■				■
	Speed Increase	■			■	■
	Passenger Capacity		■	■	■	■
	Low Operational cost		■	■		
	Attraction of Tourist		■	■		■
	Cultural Experience		■	■		
	Connectivity			■	■	
	Accessibility			■	■	■
	Goods Movement				■	■
	Reduce Pollution			■		■
	Modal Shift				■	
Cons	Eco Friendly	■				
	Reliable	■				
	Comfortable	■				
	Prone to Accident		■	■	■	■
	Restoration Cost		■	■	■	
	Limited area covered			■		
	High Traffic Zone				■	
	Implementation cost			■	■	■

Source: Author Generated

2.6 Advantages of Tram

Trams are considered a sustainable public transit mode with several advantages. A few of its advantages and attributes are discussed below:

i. **Passenger carrying capacity:** Trams have a passenger capacity of 200, whilst buses only have a capacity of 60. (WBTC, Advantages, 2014) Trams are widely used and encourage people to abandon their automobiles. Trams have eliminated at least 22 million car journeys in the UK each year. Previously, one in every five peak-hour tram passengers in the UK travelled by automobile. Half of tram riders used to go by vehicle on weekends. Since 1999, the number of tram users has increased by 52 percent. (Light rail and trams)

ii. **Eco-friendly mode of transport:** Trams are pollution-free and environmentally friendly. Travelling by automobiles emits more than three times the amount of CO2 as tram travel. (Light rail and trams) Trams emit less pollution than rubber-tired vehicles, which emit tyre, asphalt, and brake-related pollutants. (Tram, 2022) Many modern tramways with reserved right of way have green beds in between its tracks which lead to a reduction in noise, pollution, vibration, and dirt and improve the urban character. Trams can be considered as one of the healthiest modes of transportation in congested cities such as Kolkata for both young and old.

iii. **Improvement in city character:** Trams enhance a city's image while also contributing to economic revitalization. A new tram is a visible, long-term indicator that a region is being redeveloped for the future. Melbourne for example will allow higher buildings along tram routes thus increasing the city’s density. (Transport, 2010) The pedestrianization of road stretches particularly in city centres gives back the road space to NMT traffic and trams thus drawing businesses and tourists, as well as assisting people in finding jobs and services. (Light rail and trams)

iv. **Accessible, reliable, and comfortable:** Because trams are guided by tracks, they can navigate tight, curving city streets that are inaccessible to big buses. Trams can be run on former railway lines thus providing high speed service. Linking of tram lines with metro and suburban railway can allow for easy interchange of passengers and integrate the public transport

system of a city. Modern low floor trams make them universally accessible and are easy to board for children, ladies, elderly, and persons with special needs thus, providing safety and reliability.

v. **Low operational cost and long life:** Trams are extremely long-lasting, with some having been in continuous service for over fifty years. This is especially true when contrasted to internal combustion buses, which typically require extensive maintenance and break down after less than ten years, owing to engine vibrations. Because of higher carrying capacity, labour expenses (which account for most operational costs for many public transportation systems) per passenger can be much lower than on buses. Subways and other forms of heavy rail can be more expensive to build than trams and light rail systems. The often-quoted number in Berlin is that one kilometre of subway costs the same as ten kilometres of tramway. (Tram, 2022)

2.7 Arguments against tram

Although trams present a wide range of advantages to the user and public transport system, it also has certain disadvantages which cannot be overlooked. A few of these are discussed below. (Tram, 2022)

i. At ground level, tram infrastructure (such as island platforms) takes up space, often to the exclusion of other users which can also serve as an obstruction to other road users.

ii. Even though tramcars have a far longer lifespan than buses, their capital costs are higher owing to the requirement of huge infrastructure including tracks, overhead wires, platforms, and tram cars.

iii. Trams are more likely to be delayed by interruptions in their lane when operating in mixed traffic. Buses, on the other hand, can occasionally manoeuvre past impediments.

iv. Trams can slow down other means of transportation (buses, cars) when they stop in the centre of the road with no pedestrian refuges, as other traffic cannot pass while passengers alight or board the tram.

v. Cycling on tram tracks can be dangerous because bikes, especially those with narrow tyres, might get their wheels stuck in the grooves. Tram rails

become slick when wet, making them risky for cyclists and motorcycles, especially in traffic. Even automobiles can be impacted in some situations.

vi. When cornering, steel-wheeled trams are noisier than rubber-wheeled buses or trolleybuses if no further steps are taken. The wheels of older trams are connected to axles and must revolve together, but when travelling around curves, one wheel or the other must slip, resulting in loud, irritating squeals, thus causing noise pollution.

vii. As a result of drivers' unfamiliarity with tram physics and geometry, the launch of new tramway systems has sometimes been associated with a substantial increase in car accidents.

viii. A significant part of the tram network can be closed in the event of system failure or accidents, or even constructions and maintenance.

2.8 Inferences from Research Paper

2.8.1 Paper 1: 'A Profile of Tramways in Kolkata – A Sustainable Urban Public Transport' (Pramanick and Roy, 2019)

The usage of Kolkata Tramways is gradually decreasing. The number of people travelling each day has been dropping over the years, from 28.03 lakhs in 1975–1976 and 22.46 lakhs in 1984– 1985 to just 7 lakhs now, which is still a large amount when compared to the city's overall passenger flow. Trams are frequently chosen as a means of transportation because they offer a smooth and comfortable ride through the city's congested streets. In Kolkata's streets, an unchecked mixture of incompatible types of traffic causes overtaking, congestion, and therefore a lot of accidents. A tram rides on a set track and is not accountable for passing other vehicles or the problems that result from it; instead, it provides a safe trip. However, several steps are urgently required to resuscitate the form of transportation.

i. The possibility of replacing the current tram system with the LRTS (Light Rail transport System) on a few chosen lines to serve as an intermediary form of mass transport should be thoroughly studied.

ii. To make up for the loss, certain tramcars should be equipped to transport heavy products from the city's periphery to its centre and should have distinct tracks for their movement.

iii. The depots, termini, and workshops should be modernized and automated, and technical steps should be taken to make the movement of tramcars smoother and less jerky.

iv. To account for the high and low points in passenger demand, an appropriate route wise time plan must be created.

2.8.2 Paper 2: 'Tramways System: A case study of Kolkata'. (Ahmed, Khatun, 2016)

The North Kolkata crisis because of population growth, dramatically increasing motor vehicle ownership, and a variety of motorized and non-motorized transport modes using the same congested, narrow roads, traffic is getting worse every day, suffocating the passenger owing to low speed and long trip times. Time is more valuable to individuals now than ever before, but the massive rise in automobiles has exacerbated congestion and lengthened travel times. However, people continue to use the 25 KMPH tramway system in North Kolkata for public transportation.

Poor mobility has significantly slowed economic growth and reduced quality of life. Therefore, a policy is required to address this issue, which is escalating quickly. To improve the current state of Kolkata's transport system and increase the mobility of people from all social classes and age groups, this section suggests some recommendations that may be useful for several different things.

i. A distinct tram line needs to be offered to separate the diversity of the public transmission. This will improve accessibility, speed, and mobility for both the tram and other cars.

ii. The old tram engine, which cannot attain high speeds compared to other motorized vehicles due to its low power, should be replaced with a new or modified one, with a speed of 40 to 50 KMPH to minimize pollution emissions and fuel consumption by other vehicles. Reduce the irritating sound of the old tram engines as well.

iii. A separate footbridge or underground subway should be made available when 18 pedestrians are slowing down the pace of the tram.

iv. It is important to enhance tram frequency so that people can use it quickly. Intelligent Transport System (ITS) can be deployed to keep the time.

v. To prevent disruptions to other vehicles, separate tram stopping should be offered.
vi. The Level of Service (LOS) should be increased in those regions where the tram line runs such that the level of service on the road is at least D.
vii. Because of the weak drainage system in those regions where tram lines are located, during the rainy season, tram lines become submerged and unsafe for two-wheeled motorized vehicles.

2.8.3 Paper 3: "A comprehensive literature review of Multi - criteria Decision Making methods in heritage buildings" (Nadkarni & Puthuvayi, 2020)

Heritage building preservation and conservation is a difficult endeavour. Given the complexity of the decision-making process, it is challenging for urban planners, conservation architects, municipal administrators, and other stakeholders. Historic structures have a limited supply and irreplaceable cultural and historical worth. If they are not conserved in a timely manner, these structures will be forever gone. An extensive literature assessment of multi-criteria decision-making techniques in the realm of heritage conservation is included in this work.

The use of MCDM approaches as a tool for decision-makers in choosing adaptive reuse planning, appropriateness for the tourist industry, money allocation, evaluating building importance, analysing the state of heritage structures, cost calculation, etc. has been the subject of several studies. To determine the trend in research publishing and identify the MCDM techniques utilized for determining criterion weights, the paper reports on a bibliometric analysis.

For creating a database for MCDM approaches to be used for historic structures, the authors of the study analysed 42 papers. The study by authors Dutta and Hussain (Dutta & Hussain, 2009) was the first one to be released in 2009 using the criteria for evaluating the relevance of heritage buildings. This research used the Rank Order Centroid and Simple Additive Weighting methods to assign grades to Calcutta's 69 historic structures. According to the authors, the Analytical Hierarchy Process approach is used to determine criteria in 50% of studies in this subject.

2.9 Case Study

2.9.1 General

Analysing how modifications to one or more parameters of a system or model impact its performance or behaviour is known as parametric study. This kind of analysis involves methodically varying a set of input parameters to see how they affect the system's or model's output. A parametric study aims to maximize the system's or model's performance and provide a deeper understanding of its behaviour. Here are few case studies that illustrate the factors analysis.

2.9.2 Tram–Train Systems in Europe (Karlsruhe & Kassel)

A hybrid phrase, "tram-train" has been used to refer to several different kinds of transportation services. A tram-train system is described as "a railway system that produces a direct connection between a city's town centre and its regional area" in this study (Figure 8). It travels along tram lines throughout the city, sometimes on public roads, and abides by tram regulations. It operates in the area on typical heavy rail tracks and complies with heavy rail laws (along with certain extra ones). This implies that heavy rail trains on the regional rails and city trams share tracks with tram-train vehicles. Making the best use of the current infrastructure is one of the key objectives of the tram-train service.

A : Karlsruhe City Center
B : Regio Tram Kassel meets heavy rail

Figure 8: Tram -Train System
Source: Journal of the Transportation Research Board, No. 2275

Two important elements influencing passenger mode choice are travel time and comfort. Regrettably, many cities' typical commuter rail systems do not have direct connections between the city centre and their suburban rail network. As a result,

people must switch between regional and urban transit networks, which makes travel less comfortable and takes longer.

This issue is intended to be resolved by the tram-train method, which connects regional heavy railway infrastructure with urban tram systems. Direct communication between the city centre and its suburbs is made possible by the linkage, which shortens travel times, improves comfort, and boosts productivity. The ease of accessing the city centre will determine how beneficial this direct connection is now.

Investment expenses are lowered since tram-train systems typically run on pre-existing infrastructure in both urban and rural locations. Moreover, operating costs for the lightweight vehicles are lower than those of traditional trains.

With these benefits at first, a lot of people thought that tram-train systems were the best option for any city with abandoned railway tracks in the suburbs. But as evidenced by the scant number of projects implemented since Karlsruhe's successful application, they might not always be suitable.

2.9.3 Success and Challenges in Modernizing Streetcar Systems (Melbourne & Toronto)

The reason street running is the least preferred right-of-way (ROW) configuration for light rail and tram systems is that it "causes considerable friction with other vehicles, impeding both the streetcars and the auto traffic." While most developed-world cities have eliminated their streetcar networks, significant networks still exist in Toronto, Canada, and Melbourne, Australia. While some observers have viewed the continuation of these systems as visionary, resolving conflicts between streetcars and increasing traffic on the roads is a significant concern. For contemporary streetcar systems, poor running speeds, unreliability, safety, and challenges in ensuring universal access are major problems.

The planning and administration of the streetcar systems in Toronto and Melbourne are described in detail in this case study. There is a comparison between the kinds of difficulties encountered in service delivery. The difficulties of developing contemporary, high-calibre streetcar transit systems are examined, and success factors are determined for each programme.

This case study has covered several strategies for successfully modernizing streetcar systems. They are listed in the following order:

i. **Traffic Signal Priority –** Crossings are where a large percentage of streetcar delays happen. Transit-signal priority (TSP), which extends or quickly restores the green phase, can be used to reduce traffic signal delays, and increase streetcar performance by extending the running duration of transit vehicles. In Toronto, a TSP implementation programme is underway.

   TSP has been installed at about 160 transit line junctions. Each year, TSP is installed at one new route and a few additional "infill" junctions along older transit corridors; normally, between thirty and forty new intersections are equipped.

ii. **Dedicated Right-of-Way -** The separation of automobile traffic and streetcars with a dedicated, physically divided ROW has been designated as a priority by the City of Toronto and TTC. There are obvious advantages to this kind of procedure.

   As far as being able to "give streetcars the speed, safety and time advantage necessary to compete effectively with the automobile and shift commuters to transit," this is the only practical mode of operation. It provides streetcars with the speed, safety, and time advantage needed to successfully compete with cars and encourage commuters to choose public transportation.

iii. **Proof-of-payment (POP) fare system** - A proof-of-payment (POP) fare system's goal is to shorten the amount of time vehicles remain at stops. Any door on the car may be used by passengers boarding with a valid POP (i.e., transit pass or paper transfer). A paper POP is also given to travellers who pay their fee and enter through the front door. This is not the case with the pay-on-entry system that is now in place on most Toronto streetcars, where passengers are required to enter through the front door and either present a valid pass or transfer or pay a fare (precise change, ticket, or token). The main benefit of the POP system is that all doors may be used for boarding, which lowers dwell times and streetcar speeds accordingly.

iv. **Increase streetcar capacity** - In Toronto, articulated streetcars and the suggested multiple-unit concept are examples of this, as is Melbourne's deployment of the 5000 series of Combines trams. reported to be effective in Toronto; however, there is conflicting data in Melbourne, where the broader advantages of larger cars were not considered.

2.9.4 Bi-Directional Trams (Poland)

For modern cities, implementing smart and sustainable urban public transport is a significant task. Due to society's growing transportation needs, it is necessary to look for ways to make public transportation more appealing. Considering the primary goal of this paper was to ascertain the potential consequences of implementing bi-directional trams within the framework of the sustainable and smart city idea. The research technique included desk research, primary research utilizing the Delphi method, a case study, and participant observation to achieve the stated goal. The Polish city of Szczecin served as the study's research subject. The purpose of this research was to ascertain the potential outcomes of implementing a bi-directional tram within the framework of the smart and sustainable city concept. The authors of this article examined the consequences of adopting the bi-directional tram to enhance a tram system's functionality based on the outcomes of the literature review and the research findings collected using the Delphi technique.

A switch-back terminal is all that is required for a bi-directional tram to turn around instead of a tram loop (Figure 9). It gives the trams the ability to shift their direction of travel while also potentially acting as the terminus. This is especially useful when there is not enough room for a tram loop or when the area is intended to be used for other uses.

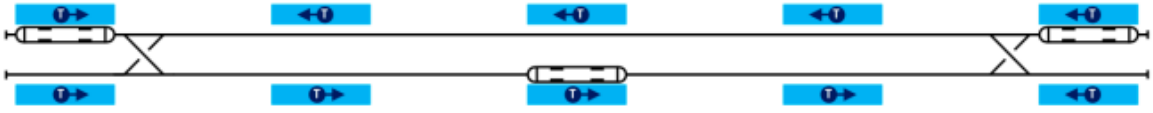


Figure 9: Operation of a bi-directional tram on a route with switch-back terminals at both ends of the tram route
Source: *https://doi.org/10.3390/en15155685*

Figure 10: Tram route terminals without applying tram loops (A) Germany (B) Belgium (C) Poland
Source: *https://doi.org/10.3390/en15155685*

2.9.5 Trams for Freight (Amsterdam)

In the context of intermodal urban freight distribution, this article examines the possible applications of electric distribution vehicles (EDVs) and trams as cargo carriers. While distribution activities are essential to society, they are also the root of many social and environmental issues. Since most logistics chains begin or end in metropolitan areas, moving products through these areas is an activity that causes serious issues for all parties involved—local government, the logistics sector, clients, and society at large, to name a few. To reduce noise, traffic congestion, and traffic pollution—such as emissions of greenhouse gases and other pollutants into metropolitan areas—new transportation solutions are required. Changing the way freight is distributed in cities could be one way to address these issues. One way to do this would be to encourage the development of multimodal transportation options, such as mixing rail and road transportation. Based on data gathered from interviews conducted in Amsterdam and a review of the literature, a conceptual model and a low-emission idea utilizing electric vehicles on Gothenburg trams are presented. The idea makes use of methods from the automobile, train, and freight industries.

There are five primary sections of the paper. First, the introduction discusses the words' nomenclature that appear throughout the study. Second, a study of the literature was done on the light rail projects that had been implemented in Europe in the past, and then a review of the literature on the usage of electric distribution trucks in Europe. Thirdly, the four main tram projects are introduced. A literature review is the source of the information from Dresden, Vienna, and Zurich, while empirical data from interviews is the source of the information from Amsterdam.

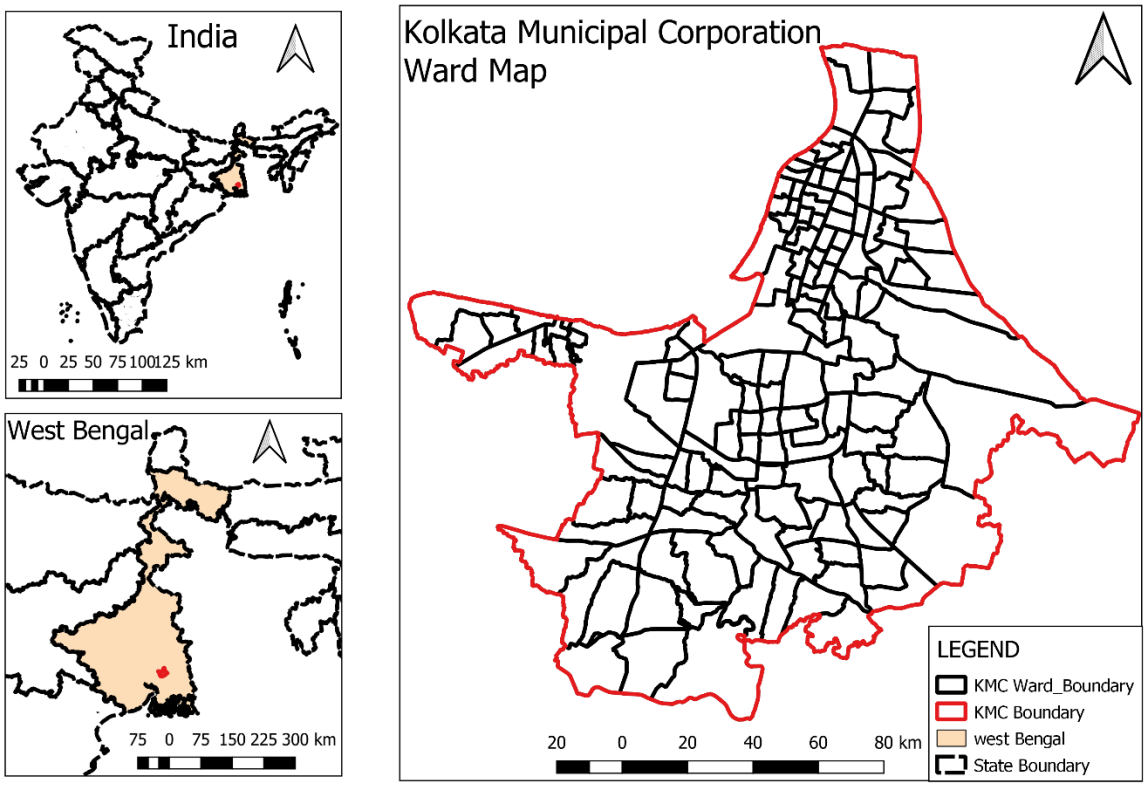
Fourth, a comparison of the cities' differences and similarities is the basis for a conversation. Finally, obstacles and suggestions are noted, and a potential future concept for the Gothenburg example city is analysed and given.

CHAPTER 3: STUDY AREA

3.1 Site Context

Kolkata reigns as the capital of West Bengal, gracing the eastern banks of the Hooghly River. It serves as the main passage for trade and communication to Northeast India and thrives as the economic, commercial, and financial heart of Eastern India. Bustling with a population of 4.5 million within the city limits and over 14.1 million in the greater metropolitan area (as per the 2011 census), Kolkata holds the distinction of being India's seventh most populous city and third most populous metropolis. In 2021, the number of registered voters in the Kolkata area crossed an impressive 15 million.

Kolkata boasts the title of India's oldest operational port, holding significance as the nation's sole major riverine port. Beyond its commercial prowess, Kolkata is celebrated as the cultural capital of India. The city boasts the second-largest Bengali-speaking population in the world, following Dhaka.



Map 1: Kolkata in India's context
Source: Author Generated

3.2 Demography

Encompassing 205 sq. km, the Kolkata Municipal Corporation (KMC) acts as the core of the much larger Kolkata Metropolitan Area (KMA) which sprawls over 1886.67 sq. km. The KMC essentially represents the densely populated urban centre of Kolkata. The KMC is currently subdivided into 16 administrative blocks (boroughs) further divided into 144 wards (including recent additions) (Map 1). These divisions translate into 21 assembly constituencies and 3 parliamentary constituencies. While large-scale industries are absent within the KMC area itself, a multitude of small-scale industries thrive here, particularly concentrated along the banks of the Hooghly River. Despite the lack of heavy industry, the KMC plays a vital role as a significant market for eastern India. It Serves as a crucial trade gateway for neighbouring nations like Nepal, Bangladesh, and Bhutan, in addition to northeast India. The Directorate of Census Operations in West Bengal has provided an official Census 2011 information for the district of Kolkata. Census authorities in West Bengal's Kolkata District also counted important individuals. In 2011, there were 4,496,694 people living in Kolkata, with 2,356,766 men and 2,139,928 women. In the 2001 census, there were 4,572,876 people living in Kolkata, of which 2,500,040 were male and 2,072,836 were female. The population of Kolkata District made up 4.93 percent of the entire population of Maharashtra. This percentage of Maharashtra's population for Kolkata District was 5.70 percent in the 2001 census.

3.3 Administrative Boundaries

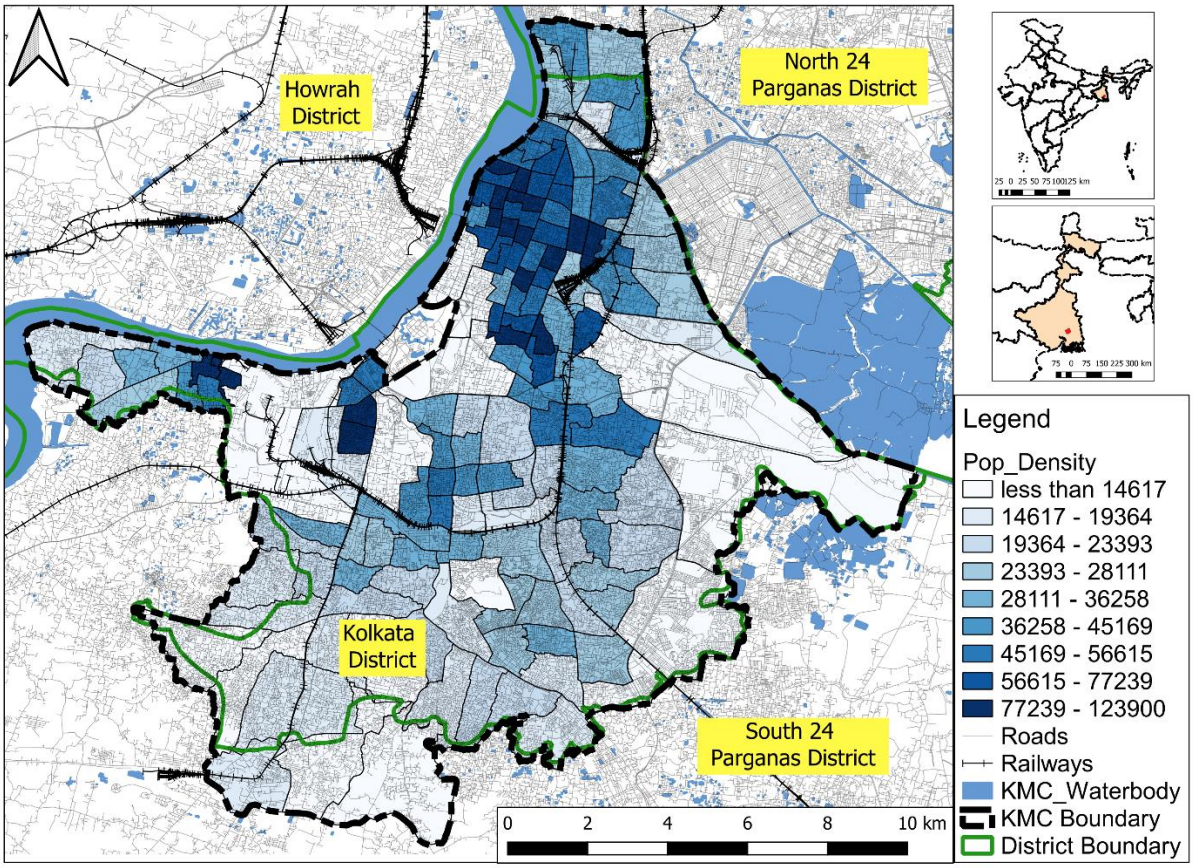
In the context of Kolkata, the terms "borough" and "ward" refer to administrative divisions within the city. Here is a brief explanation of each term:

i. Borough: A borough is a higher-level administrative division in Kolkata. The city is divided into several boroughs, each headed by a Borough Chairperson. The primary purpose of boroughs is to decentralize administrative functions and provide efficient governance at the local level. The boroughs in Kolkata are responsible for various civic services, including maintenance of roads, sanitation, water supply, street lighting, parks, and community centres. Currently, Kolkata is divided into a total of 16 boroughs.

ii. Ward: A ward is a smaller administrative division within a borough. Each borough is further divided into several wards. The number of wards in each borough can vary depending on factors such as population density and geographical area. Wards are headed by councillors who represent the residents of their respective wards. The councillors play a crucial role in addressing local issues, providing essential services, and representing the interests of their constituents. Currently, Kolkata has 144 wards.

Both boroughs and wards are integral components of the administrative structure in Kolkata. They facilitate effective governance, decentralization of authority, and ensure that local needs and concerns are addressed efficiently.

The Ward wise Population density of Kolkata Municipal Corporation is shown below (Map 2):



Map 2: Ward wise Population Density of Kolkata according to Census 2011
Source: Author Generated

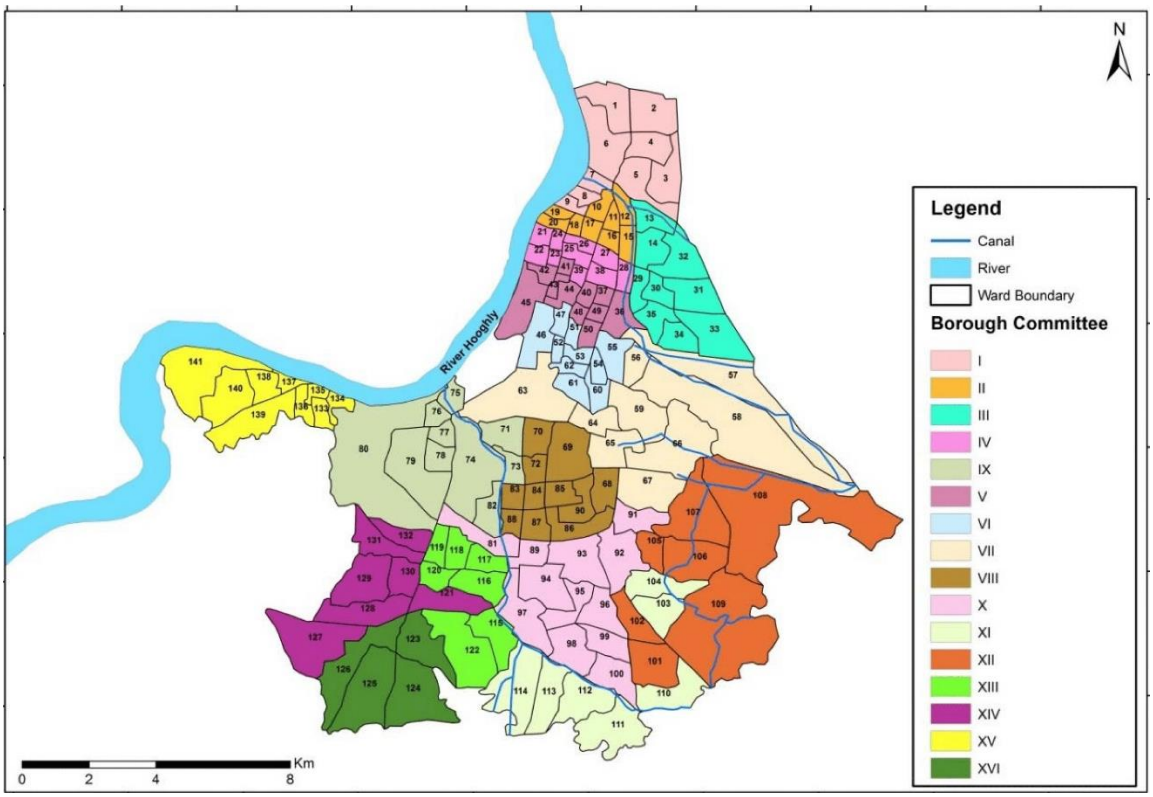
As for the population data of each ward, the latest available information is from the 2011 Census of India. Here is the population data of the 15 boroughs (each

borough has several wards) of Kolkata Municipal Corporation as per the 2011 Census (Table 3):

Table 3: Borough wise Population of KMC

Boroughs	Population
Borough I (Sinthi – Bagbazaar – Dumdum area)	407,932
Borough II (Shyambazaar – Shobhabazaar – Hatibagan area)	307,613
Borough III (Manicktala – Beleghata – Ultadanga area)	291,913
Borough IV (Burrabazaar – Jorasanko – Rajabazaar area)	332,965
Borough V (Lalbazaar – Chandni Chowk – Sealdah area)	289,351
Borough VI (Dharmatala – Entally – Taltala area)	253,077
Borough VII (Park Street – Beniapukur – Dhapa area)	238,464
Borough VIII (Chelta – Paddapukur – Bullygunge area)	337,066
Borough IX (Garden Reach – New Alipore area)	353,902
Borough X (Dhakuria – Jadavpur – Tollygunge area)	332,965
Borough XI (Bansdroni – Putiari area)	277,302
Borough XII (Garia – Santoshpur – Ajay Nagar area)	369,591
Borough XIII (Barisha – Haridevpur area)	381,022
Borough XIV (Behala – Sarsuna – Thakurpukur area)	235,784
Borough XV (Metiabruj – Mudiali area)	292,758

Source: Census 2011



Map 3: Demonstrate the borough wise ward division in KMC
Source: Kolkata Municipal Corporation, 2016

3.4 Evolution of KMC – Land Use - Land Cover Change since 1873

Researchers used a technique called supervised classification to analyse how land use within the Kolkata Municipal Corporation (KMC) has transformed over a remarkable 149 years, from 1873 to 2022. This analysis sheds light on the city's evolving spatial patterns by focusing on three major land use categories: (1) urban settlements encompassing all sealed surfaces like roads and buildings, (2) vegetation zones including roadside trees and green fields, and (3) wetlands such as ponds, lakes, and canals. The findings are presented in two parts: a comprehensive overview for the entire KMC area followed by a more granular borough-by-borough analysis to provide a deeper understanding of these land use changes.

3.4.1 Overview

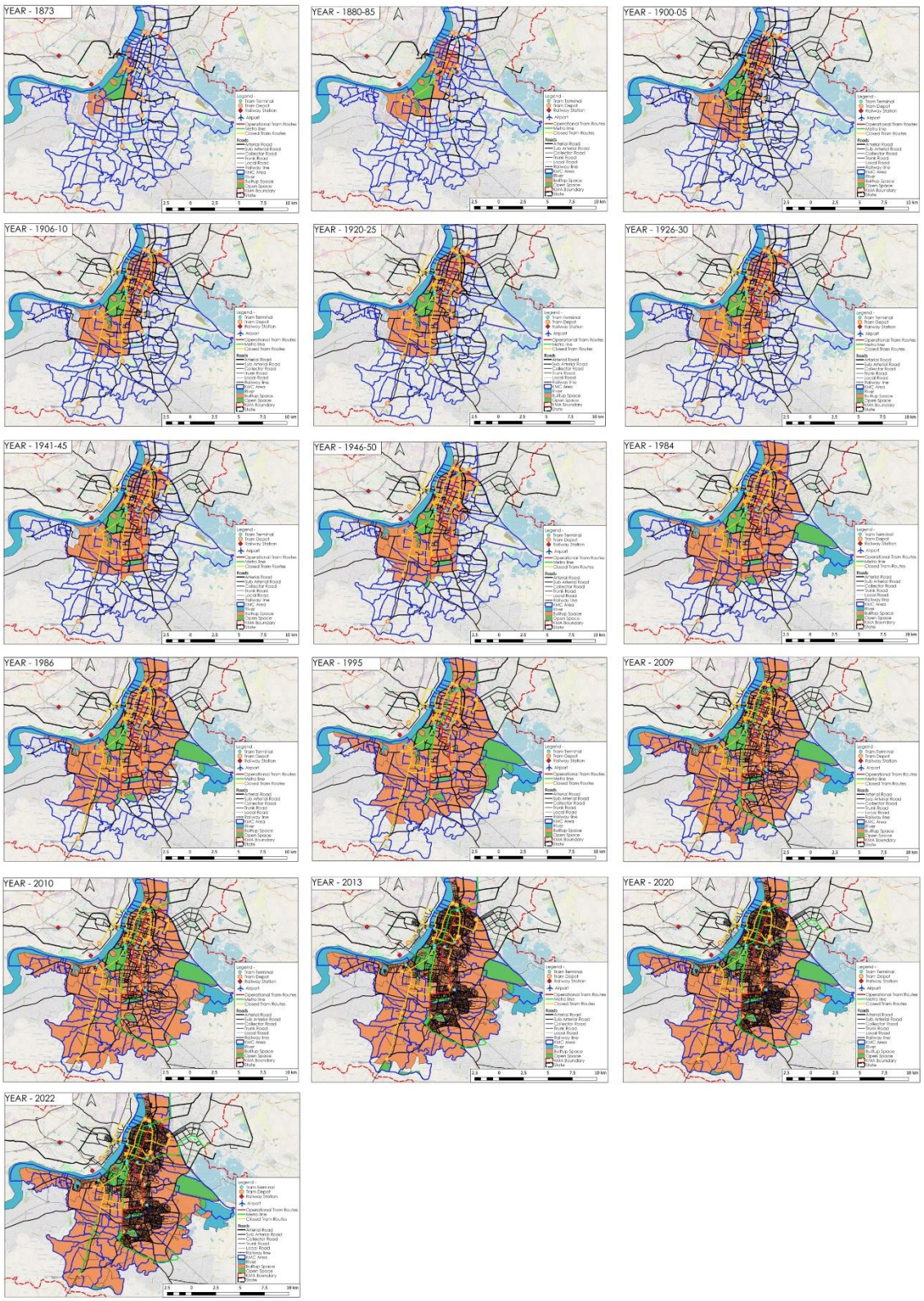
For the Kolkata Municipal Corporation area (KMC) the three major land use classes.

i. Urban settlements
ii. Vegetation
iii. Wetlands

A supervised classification technique analysed land-use changes within the Kolkata Municipal Corporation (KMC) across a staggering 149 years, revealing significant shifts in spatial patterns. The study divided this period into sixteen time slices spanning 1873 to 2022. Most notably, urban settlements exhibited a dramatic rise. In 1980, they occupied only 49% of the KMC area. By 2020, this figure had skyrocketed to 79%, signifying that nearly the entire area (161.91 sq. km) was now classified as urban settlements (Map 4). Interestingly, the growth between 1980 and 1990 for urban settlements was minimal, with a mere 2% increase from 100.17 sq. km to 103.89 sq. km. However, a turning point came between 1990 and 2010. During this period, urban sprawl accelerated rapidly. The area covered by urban settlements reached 71% (145.34 sq. km) in 2000, followed by another substantial increase of 7% by 2010. By then, a staggering 78% or 162.08 sq. km of the total KMC area was classified as urban (Map 4). This data highlights the dramatic transformation of Kolkata's landscape over the past century and a half, with a clear trend towards increasing urbanization.

The study revealed a concerning trend of dwindling natural spaces within the Kolkata Municipal Corporation (KMC) over the 149-year period (1873-2022). Wetlands bore the brunt of this decline, with their area contracting from a substantial 47.15 sq. km to a meagre 8.70 sq. km (Map 4). Vegetation patches also suffered significant losses, shrinking from 58.60 sq. km to 35.31 sq. km. Interestingly, bigger trees formed a dominant part of the vegetation cover in 1980, sprawling across an impressive 29% (58.60 sq. km) of the KMC area. This green cover even flourished, reaching a peak of 39% (81.12 sq. km) by 1990. However, a concerning shift began thereafter. The area under vegetation patches went into a steady decline, dipping to 21% in 2000 and finally settling at a concerningly low 17% in 2022 (Map 4). It is important to note that Figure 10 might show a slight increase in vegetation cover in specific pockets of eastern and southern Kolkata between 2010 and 2020. However, this localized rise fails to negate the overall trend of habitat loss throughout the KMC. This highlights the urgent need for sustainable development strategies that prioritize the preservation of Kolkata's dwindling natural spaces.

The analysis exposed a complex interplay between wetlands and vegetation within the Kolkata Municipal Corporation (KMC) during the 149-year period (1873-2022). While the overall trend pointed towards a decline in both wetlands and vegetation cover (Map 4), a closer look reveals a fascinating shift. Wetland areas witnessed a drastic reduction, plummeting from a significant 47.15 sq. km to 20.90 sq. km. Interestingly, this does not necessarily imply a direct conversion to urban spaces. Data suggests that these wetlands might have undergone desiccation and subsequently became overgrown by vegetation (Map 4). The most dramatic wetland loss occurred between 1980 and 1990, with their extent shrinking by more than half, from 23% to a meagre 10% of the total KMC area. The subsequent decades saw a continued decline in both wetlands and vegetation. By 2020, wetlands had dwindled to a precarious 4% (8.7 sq. km) of the KMC, although this represented a slight increase (1%) compared to 2010 (7.42 sq. km). This information underscores the need for further investigation into the factors affecting Kolkata's wetlands and the potential ecological consequences of their transformation into overgrown areas.



Map 4: Evolution of Tram with decade wise Distribution of Urban Settlements in KMC (1873 - 2022)

Source: Author Generated

Geo Journal (2022) 87 (Suppl 4):S551–S566
https://doi.org/10.1007/s10708-022-10581-z

https://www.calcuttatramways.com

3.5 Comparison with Other Metropolitan Cities

Although India is now a hub of 9 metropolitan cities (Including Delhi, Mumbai, Kolkata, Chennai, Ahmedabad, Bangalore, Hyderabad, Pune, and Surat), 4 leading Indian Metropolitan cities are compared here to understand national scenario in India. Sure, here is a comparison of the transportation systems in Kolkata, Mumbai, Bangalore, and Chennai based on available data:

i. Kolkata: - Metro Rail: Kolkata has the oldest underground metro system in India. It currently has a single operational line and a total length of 27.22 km with 24 stations. The city has plans to expand the metro system with multiple new lines in the future. - Buses: Kolkata has an extensive bus network with both state-run and private operators. According to a 2019 report, Kolkata had around 6,000 buses plying on its roads. - Trams: Kolkata is also known for its tram system, which is the only operating tram network in India. It covers a length of 16.3 km and has a total of 25 stations.

ii. Mumbai: - Local trains: Mumbai's suburban railway system is the lifeline of the city's transportation network. It has a total length of around 465 km and carries over 7.5 million passengers daily. - Metro Rail: Mumbai also has a metro rail system, with one operational line and a total length of 11.4 km. Several new lines are under construction or in planning stages. - Buses: Mumbai has a large bus network operated by both state-run and private operators. As of 2019, it had around 4,000 buses in operation.

iii. Bangalore: - Metro Rail: Bangalore has a metro rail system that currently has two operational lines with a total length of 42.3 km and 41 stations. More lines are under construction or in planning stages. - Buses: Bangalore has an extensive bus network operated by both state-run and private operators. As of 2021, it had around 6,400 buses in operation. - Auto-rickshaws and taxis: Auto-rickshaws and taxis are also a common mode of transportation in Bangalore.

iv. Chennai: - Metro Rail: Chennai has a metro rail system that currently has two operational lines with a total length of 45 km and 32 stations. More lines are under construction or in planning stages. - Buses: Chennai has a large bus network operated by both state-run and private operators. As of 2021, it had around 4,500 buses in operation. - Suburban trains: Chennai has a

suburban rail network that connects the city with its suburbs and nearby towns. It has a total length of around 640 km and carries over 1 million passengers daily.

Overall, all four cities have a mix of transportation options, with each having their own strengths and weaknesses. However, Mumbai and Kolkata have particularly well-developed rail networks, while Bangalore and Chennai have invested more in expanding their metro systems in recent years.

3.6 CTC – Overview of Calcutta Tram Corporation

The oldest continuously operating business of its sort in Asia is the tram system in Kolkata, which was founded in 1873. The Calcutta Tramways Company (CTC) was formally established in 1880 to manage the business. Before trams were electrified, the firm had 166 horse-drawn trams operating on a 19-mile line. The CTC now operates 275 trams with a 200-passenger capacity. Seven tram depots are located throughout the city (Basu, 2014).

The CTC is in a crisis, having had to eliminate more than half of its tram lines just in the previous ten years due to dramatically dropping tram ridership over time and rising operating expenses. Other factors contributing to the CTC's deteriorating condition include their inability to postpone paying their energy and transformer oil bills, the fact that they barely make enough money each day from operating trams to pay the salaries of less than a thousand workers, and the fact that the location of their trams makes it difficult for potential passengers to reach them.

To make matters worse, the CTC added to its financial problems by spending money to upgrade the trams' infrastructure, such as installing air conditioning in them. These trams were then leased to the city's tourism department to be used in a "Heritage Tour" of the city, which costs 260 per ticket. However, the move was unsuccessful, the Heritage Tour campaign fared poorly, and tram use continued to decline (Dey Oindrila, 2017).

According to The Economist, trams will not be able to compete with modern forms of transportation, both economically and in terms of convenience. Many financial analysts say trams are outmoded and unprofitable. The Federal Transit Administration's 2010 survey, for instance, found no evidence that tram systems were significantly stimulating employment or the economy. Nevertheless,

developers continue to argue that trams are essential for creating jobs and raising employment rates, despite the lack of empirical evidence to support their claims. The construction of tracks and the production of trolleys also come at a high expense.

However, Kolkata has been able to maintain tram service whereas every other significant Indian city has all but eliminated it. The low cost of the fare is the cause of this. “The magazine Desh used to cost 1.5 annas while our ticket was 1 anna. Desh now costs Rs 2.50, and we have only reached 35p, according to CTC chief A.K. Dutta”.

Since its founding, the CTC has experienced significant adjustments. It was officially nationalized in 1976 after being taken over by the West Bengal government's transport department in July 1967, but it returned to almost its previous status when a government-owned corporation was established on February 1st, 1983. It now performs the same duties as a public sector firm and can get a market loan.

Today's trams are still operating thanks in large part to the CTC. The management contend that far than being outdated, trams might really be the solution to India's failing urban transportation infrastructure. Their case is strengthened by the National Transport Policy Committee, led by B.D. Pande, which stated in 1980 that all efforts should be made to expand the current Calcutta tram service and that tramways should also be introduced in the major cities of Hyderabad, Bangalore, Ahmedabad, Kanpur, and Pune (Dey Oindrila, 2017).

The fact that trams rely on an exclusive supply of around 17 MW per day, which is never reduced, is another important reason in the sustainability of the tram system in the metropolis plagued by a chronic power crisis. Sometimes there could be a quick cut for a few seconds, but never longer. The system is treated as a priority region and is powered by ten substations of the Calcutta Electric Supply Corporation. As a result, electricity outages seldom leave travellers stranded (Singh, 1984).

3.7 Cycle of Negligence – CTC Trams

Throughout the history, the tramway system in Calcutta has been forced to go through a vicious cycle of negligence, especially during the post-independence

years. This cycle of neglect was prudently executed by each one in power across the last 50 years or so.

The utter negligence left the tramway system stagnate at a technological era that dated back to the mid-20th century and hence, neither the rolling stock nor the infrastructure saw much improvement. This decades-long negligence and subsequent public declaration by certain ministers denouncing the tramway system by various means resulted in a change of public perception which is where the cycle of negligence started:

i. Successive government's failure to maintain a proper transport system through utter neglect.
ii. Tram service and rolling stocks along with infrastructure fell into disrepair.
iii. No proper maintenance and modernization.
iv. People did not get the desired service and started to shy away from using them.
v. Patronage, as well as the revenues dropped.
vi. Successive governments used the same excuse of less revenues behind not modernizing the system. g. Successive governments failed to maintain a proper transport system.

In the 1920s, the government began to focus on developing other modes of transportation, such as buses and trains. The CTC, however, continued to operate the trams, and the government did not invest in the system. As a result, the trams began to deteriorate, and the tracks became worn and dilapidated. This led to frequent breakdowns and accidents.

During the 1940s and 1950s, the situation worsened. The trams were old and unreliable, and the tracks were in poor condition. Moreover, the government had begun to focus on developing the metro system, and the tram system was neglected further.

In the 1960s and 1970s, the Kolkata tram system was on the verge of collapse. The trams were old and unreliable, and the tracks were in poor condition. Moreover, the government did not invest in the CTC to modernize the system. This led to a decline in the popularity of the trams, and commuters began to use other modes of transportation.

In the 1980s and 1990s, the government began to take some steps to improve the tram system in Kolkata. The tracks were repaired, and some new trams were purchased. However, these efforts were not enough to revive the system, and the tram system continued to decline.

Today, the Kolkata tram system is a shadow of its former self. The trams are old and outdated, and the system is no longer popular with commuters. Despite efforts to modernize the system, the neglect of the Kolkata tram system over time has led to its decline.

3.8 Recent Issues – Kolkata Tramways

The Kolkata tram system, while lauded for its minimal air pollution compared to other modes of transport, faces criticism for noise generation, particularly from older models. The Chief Justice himself acknowledged this as a major public complaint and emphasized the government's responsibility to curb noise pollution (Dey Oindrila, 2017). Rubber wheel belts have been proposed as a potential solution to dampen vibrations and lessen the noise (Legal reporter 2016). However, the source of the electricity powering the trams presents another challenge. While electric operation eliminates tailpipe emissions within the city, it relies on energy generated by burning fossil fuels in coal-fired plants (Dey Oindrila, 2017). This highlights the complex trade-off between air quality and noise pollution associated with Kolkata's tram system, suggesting a need for exploring solutions that address both concerns.

And in a city like Kolkata, which is so crowded, the trams are more of a nuisance than a service. Because people voluntarily switched from private to public transportation, tramways are successful everywhere in the world but not in Kolkata. In Kolkata, this transformation did not occur, which is why the city is currently dealing with so many problems. Even though the CTC has a serious funding problem, they have not done anything to highlight how environmentally beneficial trams are.

Trams can replace many vehicles, but they are constrained by tram lines and are unable to change their direction to accommodate traffic, which was cited as another important justification for phasing them out. Trams can only be space-efficient if their routes are carefully planned to be incorporated into cities, which has been

effective in European nations but catastrophic in Calcutta due to its unrestrained, exponential expansion without appropriate planning. (Ghosh 2016).

Although there are several good reasons to doubt trams' feasibility, many would contend that their eco-friendliness justifies the work required to implement them on a broad scale. Some theories that the reason trams are being phased out is because the State Government is greedy and wants to sell property owned by the CTC to earn money to pay for the enormous losses.

CHAPTER 4: SITE VISIT AND DATA COLLECTION

4.1 General

Data collection is a crucial part of the research project. It is the process of collecting and assessing information based on relevant attributes in a systematic manner. The process of data collection allows the researcher to answer research questions and analyse possible outcomes. Data should be adequately useable and reliable for better Analysis. It is carried out through field studies, inventory data, personal interviews of the various stakeholders and beneficiaries. Field studies give an accurate picture of the existing scenario of the study area. This chapter includes data collection methodology with the data source. To carry out the research requirements, primary and secondary data are collected.

4.2 Primary Data Collection

The process of data collection is relevant to the objectives defined and the outcomes expected from the study. A more detailed and comprehensive study is essential to assess the collected information in two basic components, viz. primary data sources and secondary data sources. The primary data usually referred to data originated from field surveys and collected by the researcher. Here physical survey of existing Tram Routes, Depots, Tramcars carried out to get the existing scenario. Semi-structured interviews of various stakeholders including, city officials, and the Tram users were conducted for primary data collection. Questionnaires were also prepared to understand public perception for Kolkata Trams. The list of Interviewees (Officials, local experts) for primary data collection are shown below:

i. Dr. Utpal Roy (Associate Professor), Dept. of Geography, University of Calcutta
ii. Ar. Sumon Gupta (Architect & Planner), Aakriti, Kolkata
iii. Ar. Diptiman Samanta (Architect & Planner), Aakriti, Kolkata
iv. Subham Pramanick (Senior Research Fellow), Dept. of Geography, Ballygunge Science College
v. Indranil Maity (Research Assistant), Dept. of Geography, Ballygunge Science College

vi. Fayaz Ahmed (Manager), RITES Ltd.

4.2.1 Questionnaire and Surveys

A quantitative analysis on one of the key stakeholders in the tramways system, the public, was conducted because of the research to better understand the factors influencing the survival of the tramway systems in Kolkata. In this sense, both those who use trams and those who do not become significant factors to consider. For the study of Kolkata's residents, an in-person survey was conducted to learn why trams were still in use, why they were such an important part of the city, and whether tram elimination would have an impact on people's daily lives. The primary goal was to achieve a perception of citizens of Kolkata about the trams, so questions were asked about their demographics, their personal and family income levels, how frequently they used the trams, what other forms of transportation they used, how satisfied they were with the tram services and how well they were currently being provided, whether they thought the trams would survive, whether they wanted them to survive, and other things.

4.2.2 Sample Identification and Description

We sought to distribute and fill out questionnaires in several areas of Kolkata, including Esplanade, Ballygunge, Bidhan Nagar, Tollygunge, College Street, Salt Lake and Kalighat, to get information from a diverse group of individuals. 132 people made up the sample. 60 women and 72 men made up the group. The age group was broken down into five groups: under 18, 19 to 35 (students and young professionals), 36 to 50 (senior professionals, early middle-aged citizens), 51 to 65 (late middle-aged citizens), and above 65 (senior citizens).

4.3 Inventory Data

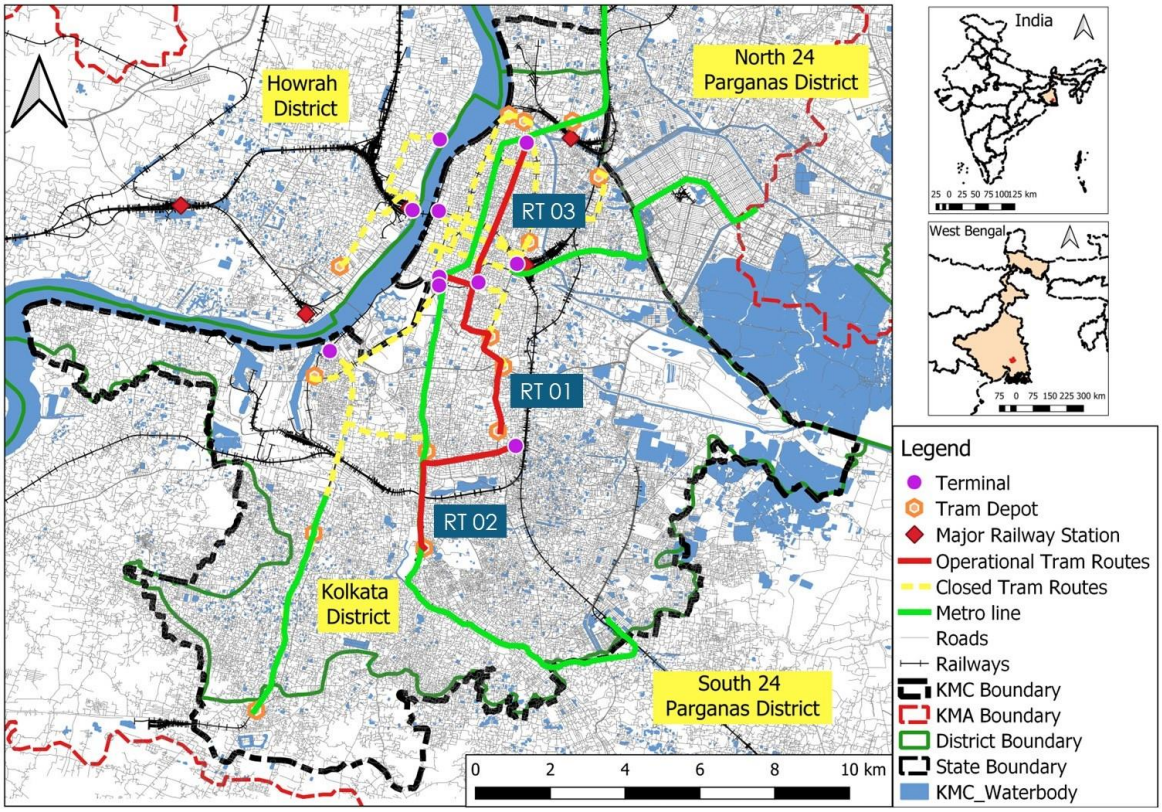
Inventories allow the researcher to understand the extent of site visits needed and avoid unnecessary delay of the work due to existing data collection. Before commencing field studies, the preliminary information from sources like gazetteers, manuals, development plan reports, mobility plan reports, and manuals containing information about the Kolkata Tramways was gathered and documented. The reports were collected from the Kolkata Municipal corporation, Kolkata

Metropolitan Development Authority (KMDA), West Bengal Transport Corporation (WBTC) Office and Paribahan Bhavan.

4.4 Road Network Inventory Survey

Despite having over 37 defined routes from Initial Stages, currently only 3 routes are operational. Road Network Inventory survey has been done on 9 routes out of which 3 routes are operational and 6 routes are closed routes (Map 5).

i. Ballygunge – Tollygunge (Operational route)
ii. B.B.D Bag – Gariahat (Operational route)
iii. B.B.D Bag – Shyam bazar (Operational route)
iv. Howrah Bridge – Belgachia (Closed route)
v. Howrah Bridge – Bidhan Nagar (Closed route)
vi. Khidirpore – Esplanade (Closed route)
vii. B.B.D Bag – Bagbazar (Closed route)
viii. B.B.D Bag – Raja bazar (Closed route)
ix. Kalighat – Khidirpore (Closed route)



Map 5: Detailed Tram Routes in Kolkata
Source: Author Generated

4.5 On Board Public Transport Survey

To get an overall idea about trip purpose, trip frequency, users' profile, and OD data. On board Public Transport survey has done on 3 operational Tram routes. A Total 53 samples collected.

i. Ballygunge – Tollygunge (Operational route) – 22
ii. B.B.D Bag – Gariahat (Operational route) – 14
iii. B.B.D Bag – Shyam bazar (Operational route) - 17

4.6 Organizational structure – WBTC

The West Bengal Transport Corporation (WBTC) is a state-owned public transport company in West Bengal, India. The company is responsible for providing various transportation services including buses, trams, and waterways in the state of West Bengal.

WBTC has a hierarchical organizational structure with several levels of management. The structure is as follows:

i. Board of Directors- The Board of Directors is the highest level of management in the organization. It is responsible for the overall strategy and policy decisions of the company.
ii. Managing Director- The Managing Director is responsible for the day-to-day operations of the company. They oversee the various departments and ensure that the company's objectives are met.
iii. General Manager (Operations)- The General Manager (Operations) is responsible for the overall operation of the company. They supervise the different departments and ensure that the transportation services are delivered efficiently.
iv. General Manager (Administration)- The General Manager (Administration) is responsible for the administrative functions of the company. They oversee the finance, HR, and legal departments.
v. Chief Engineer- The Chief Engineer is responsible for the maintenance of the company's transportation infrastructure. They oversee the repair and maintenance of buses, trams, and other vehicles.

vi. Divisional Manager- The Divisional Manager is responsible for the transportation services in a particular division or region. They oversee the operations and ensure that the services are delivered efficiently.

vii. Departmental Manager- The Departmental Manager is responsible for a specific department within the organization. They oversee the daily operations of the department and ensure that the objectives are met.

Overall, the hierarchical structure ensures that WBTC can efficiently manage its transportation services and meet the needs of the people of West Bengal (Figure 11).

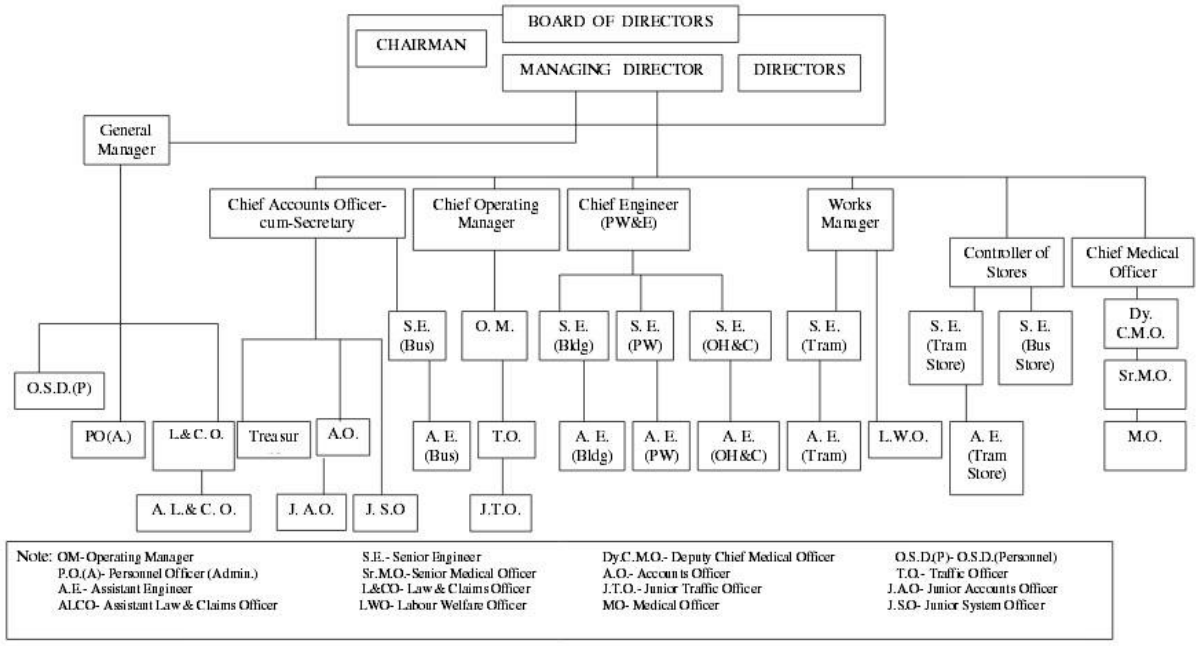


Figure 11: Organizational Hierarchy of WBTC
Source: https://wbtc.co.in/

CHAPTER 5: DATA ANALYSIS

5.1 Analysis to Identify the reason of Tram route closures post 2000

In a bid to understand the factors behind tram route closures in Kolkata, researchers embarked on a comprehensive investigation. This primary survey employed a two-pronged approach, utilizing both visual and social elements. A photographic survey documented the current state of closed tram routes, capturing their infrastructure and surrounding areas. Stakeholder discussions, another crucial piece of the puzzle, were conducted along all affected routes. These discussions included a diverse range of individuals: tram users, those indirectly impacted by tram operations (passive tram users), and officials responsible for administration and law enforcement. To ensure a holistic understanding, tram routes, depots, and terminals were meticulously mapped using GIS software. Finally, by carefully analysing stakeholder perspectives alongside the visual data and mapped infrastructure, researchers were able to draw inferences about the reasons behind closures and suspensions. This multi-faceted approach provides valuable insights into the complexities surrounding tram route closures in Kolkata. Delving deeper into the findings, the research team meticulously analysed the data gathered through site inspections and stakeholder discussions. This analysis yielded a clear understanding of the reasons behind each tram route closure or suspension. The following breakdown details the specific factors that contributed to the in operation of various routes, providing valuable insights into the challenges faced by Kolkata's tram system.

i. The Behala-Khidirpur tram link, originally part of the Joka-Khidirpur route, met an unfortunate fate. Initially, a temporary suspension was implemented to facilitate the construction of the Taratala flyover. Plans existed to realign the tram line alongside the completed flyover, offering a permanent solution. However, these plans never materialized, leading to the permanent closure of the route. This closure severed a vital transportation link. The route not only provided connectivity with the crucial Majerhat station on the circular railway but also functioned as a direct link between the southernmost reaches of Kolkata and the central hub of Esplanade via Khidirpur. This

permanent closure significantly impacted the travel options for residents in the southern part of the city.

ii. The closure of the Dalhousie terminal was not just the demise of a single location; it marked the severing of vital connections for several tram routes. To facilitate the construction of an underground car park near the state Secretariat and the terminal itself, the decision was made to permanently shut down Dalhousie. This closure rippled outwards, impacting tram routes originating from areas like Sealdah railway station, Bidhannagar, and Shyambazar. These routes played a crucial role in transporting passengers directly to the city's central business district, a hub brimming with government offices, private companies, and bustling markets. With Dalhousie's closure, residents from these areas lost a convenient and economical tram connection to the heart of Kolkata's commercial activity. The impact was not just on commuters; businesses that relied on foot traffic from tram riders also likely felt the strain. This instance highlights the domino effect that infrastructure changes can have on a city's transportation network.

iii. The Behala-Joka tram route suffered a double blow, ultimately succumbing to the march of progress. Originally boasting a dedicated right-of-way and known for its efficient and speedy service, this route was the first victim of the expansion plans for Kolkata's North-South metro corridor. Construction of the elevated metro line necessitated the permanent closure of the Behala-Joka link. While geographically isolated from the rest of the tram network after the 2002 closure of the Behala-Khidirpur link, the Behala-Joka route provided a vital service within its own microcosm. The Calcutta Tramways Company had even established a mini workshop at the Joka tram depot to ensure smooth operations through minor maintenance and repairs. Though it once connected directly to Esplanade, the route's primary function in its later years was to ferry residents from southern neighbourhoods to the bustling commercial hub of Behala. This closure not only severed a link to a major business district but also disrupted the daily commutes of many who relied on the tram's efficiency for their intra-city travel.

iv. The closure of the tram routes operating between Galiff Street and Bagbazar terminals, and onwards to Esplanade and Howrah Bridge terminals, dealt a blow to both public transport accessibility and the historic character of North Kolkata. While the stated reason was excessive congestion on Rabindra Sarani, a narrow street with a right-of-way of less than 10 meters, the decision prioritized private vehicles over a more sustainable and space-efficient mode of transport. This closure also stemmed from legal disputes with residents around the Bagbazar terminal. This tram route served as a lifeline for residents and businesses in the area. It provided seamless connectivity through narrow streets where buses could not navigate, making it an essential part of daily commutes and commercial operations. The route's significance extended beyond practicality; it weaved through the vibrant tapestry of North Kolkata. Passengers were offered a glimpse into the bustling commercial markets of Bara Bazaar, Tirreti Bazaar, and Bagri Market, alongside architectural gems like Nakhoda Masjid and Jorasanko Thakurbari, the ancestral home of Rabindranath Tagore. Furthermore, the route offered a vital connection between the central business district and the ferry services at Bagbazar terminal. The elimination of this tram route not only disrupted travel patterns but also severed a valuable link to the cultural heritage of the area.

v. The Kalighat-Khidirpur tram route, a historic link that connected the city's oldest tram depot (Kalighat) to the bustling industrial and commercial area of Khidirpur, fell victim to an unfortunate incident. The collapse of the Majerhat Bridge in 2018 triggered safety concerns about the Kalighat Bridge, leading to its permanent closure for tram services. Fearing compromised structural stability, the West Bengal government appointed an expert committee to assess all bridges over 50 years old. Their study revealed a harsh reality: acidic and toxic fumes emanating from the polluted waters of the Tolly Nullah had taken a toll on the bridge's health, deeming it unfit for tram operations. This closure severed more than just a physical link. The route served as a familiar sight for students attending prestigious institutions like St. Thomas College of Engineering and Technology and St. Teresa's Secondary School. It also offered convenient access to the

Laxmipat Singhania Academy, the Alipore District and Sessions Court, and even Alipore Central Jail. Further adding to its significance, the route provided a crucial connection point with the metro corridor at Hazra and Rashbehari stations. The loss of this tram line not only disrupted daily commutes for residents and employees in these areas but also weakened the overall connectivity of the city's public transport network.

vi. The expert bridge committee's verdict on the Belgachhia Bridge proved to be a harsh blow to the city's tram network. Deemed unfit for tram operations due to structural concerns, the bridge effectively cut off all tram routes extending to the Belgachhia tram depot. This closure forced the curtailment of these routes, leaving Shyambazar tram terminal as the new endpoint. The situation was particularly disheartening considering the recent (2018) completion of concretization work on the Belgachhia Bridge tram tracks. This project, undertaken to improve the track's condition and potentially extend tram operations, turned out to be a waste of valuable capital resources. The abrupt closure left many questioning the foresight behind the concretization project and highlighted the challenges faced in maintaining Kolkata's aging tram infrastructure.

vii. The COVID-19 lockdown threw a spanner in the works for tram commuters, particularly those who relied on routes originating from the Howrah Bridge terminal. These trams, which once traversed the bustling Mahatma Gandhi Road, remain suspended even as the city inches back to normalcy. While the West Bengal Transport Corporation (WBTC) has hinted at a revival, a concrete timeline for the return of services from Howrah Bridge terminal is frustratingly absent. The official explanation points towards the heavy congestion that plagues Mahatma Gandhi Road, the crucial westbound approach to the Howrah Bridge (refer to Figure 36 for a visual representation of the traffic situation). This gridlock seems to be a major hurdle in resuming tram operations along this route. It is important to remember that this route served as a vital link, connecting various parts of the city to the iconic Howrah Bridge and the bustling commercial and transit hub of Burra Bazaar. With its current suspension, commuters have lost a convenient and economical way to access these key areas. The unanswered question

remains: will the trams return, or will this suspension become a permanent disruption to Kolkata's public transport network?

viii. A shadow fell over Kolkata's most iconic tram route - the Esplanade-Khidirpur line (Route 36) - in the wake of the COVID-19 lockdown. This grand old dame of the city's electric tram network, boasting the distinction of being the oldest electrified route, currently remains suspended. A double whammy dealt the trams a heavy blow. Firstly, the construction of the Esplanade metro terminal, a vital part of the East-West metro corridor, blocked their entry point at the Esplanade terminal. Secondly, the ferocious cyclone Amphan, which lashed Kolkata in May 2020, wreaked havoc on the city's infrastructure, damaging the route's overhead wires and other elements. This route was not just a mode of transport; it was an experience. With a reserved right-of-way for most of its journey, the tram glided past the sprawling greens of the Maidan, offering passengers a breathtaking vista of the city skyline. It served as a vital artery, connecting the industrial and commercial hub of Khidirpur to the bustling heart of Kolkata - the Esplanade, a central business district teeming with commercial activity, prestigious institutions, and tourist attractions. The current suspension leaves a void in the city's public transport network, and many residents wait with bated breath to see if this iconic tram route will once again grace the streets of Kolkata.

5.2 Stakeholder discussions to understand the Tramway System of Kolkata

Interviews and discussions were carried out with various stakeholders of the tram network to understand their views on tramway system of Kolkata. Discussions were carried out at locations. The stakeholders included persons who use trams frequently or rarely, persons who are directly or indirectly affected by the operations of trams and persons from the administrative, Academician, Researcher, Individual Professionals, and Tram users of Kolkata. Excerpts from interviews with Experts are discussed below:

"It is the only sustainable mode of transport presently available in the city. Tramways are being researched by other foreign nations to improve their viability as a means of transportation. India contemplates that as well."

- Subham Pramanick (Senior Research Fellow)

"The primary issue is that the city does not have a master plan. The one that was created in the past was flawed and the modal split did not consider the current situation."

- Dr. Utpal Roy (Associate Professor)

"If speed is increased, then definitely tram should replace bus/auto/mini bus where road width is minimum."

- Ar. Diptiman Samanta (Principal Architect)

"Increased no of vehicles leading to congestion in roadways which leads to slow speed of tram."

- Ar. Sumon Gupta (Principal Architect)

Excerpts from interviews with tram users are discussed below:

"Tram network should be spreaded. It may not be the older ones but the modernized technology can be supported as it is very accessible."

- Tram user on Gariahat-Shyambazar route

"Tram is an alternative way out to establish sustainable mobility. In Kolkata, Tram is an emotional heritage too. World is moving towards zero emission and sustainable mobility concept - "Tram is one of the solutions"

- Tram user on Tollygunge – Ballygunge (Route 24/29) route

"AC trams are good, but not available on many routes. No charging point and Wi-Fi also available"

- Tram user on Tollygunge Depot

“Tram is a cheap and green transport medium; it should be properly and implemented “

- Tram user on Gariahat Depot

The reaction among active tram users is varied and justified. There has been a marked increase in the number of autos since the removal of trams. Autos have replaced the trams plying on Joka – Behala route and Kalighat – Khidirpur route. It is the view of a parking attendant that auto drivers drive very rashly on the road which poses a danger to auto users, other vehicles, and pedestrians on the road. Others passive users feel that trams were a thing of the bygone era and newer modes of mass transport such as the metro will serve the people better which is justified with its high speed and connectivity. Others feel that congestion was a major issue such as the case of Rabindra Sarani which has a right of way of less than 10 metres. This is a historic route passing by many heritage buildings and connecting the oldest neighbourhoods of Kolkata. Reserving the road for either trams or private vehicles is a very sensitive issue which can be implemented for the revival of trams on the route.

It can be concluded that the general view of Kolkata tram users is that they want to see trams functional and operational at full capacity throughout the city so that it can regain its status as a major mode of public transport in the city.

5.3 SWOT Analysis of Kolkata Tramways

The Kolkata tram system presents a unique case for a SWOT analysis, showcasing its strengths, weaknesses, opportunities, and threats in the context of modern urban mobility.

Starting with strengths, the tram system boasts a rich heritage and cultural significance, making it a tourist attraction and a symbol of Kolkata's history. Its extensive network covers significant parts of the city, providing connectivity to both residential and commercial areas. Moreover, trams are environmentally friendly, running on electricity and contributing to sustainable transportation options.

However, weaknesses in the system are apparent. The infrastructure is aging, leading to concerns about reliability and safety. Limited modernization efforts have been undertaken, affecting the system's efficiency and attractiveness to

commuters. Operational challenges, such as traffic congestion and delays, further hamper its competitiveness compared to other modes of transport.

Despite these challenges, there are opportunities for the Kolkata tram system. With increasing focus on sustainable mobility, there's potential for revitalization through modernization initiatives, including upgrades to tracks, rolling stock, and technology integration for real-time tracking and scheduling. Integration with other modes of transport, such as metro and buses, can enhance its overall accessibility and appeal.

Nevertheless, threats loom over the tram system. Competition from emerging transport services like ride-sharing and bike rentals poses a challenge, especially among younger demographics. Financial constraints and limited government support for infrastructure upgrades could impede revitalization efforts. Additionally, changing urban landscapes and development priorities might prioritize other transport modes over the tram system.

In navigating these factors, a strategic approach balancing heritage preservation, modernization, financial sustainability, and integration with broader urban mobility plans is crucial for the Kolkata tram system's continued relevance and success (Figure 12).

Figure 12: SWOT Analysis of Kolkata Tram
Source: Primary Survey by Author

5.4 User Characteristics Kolkata Tramways

The user characteristic of the Kolkata tramways encompasses a diverse range of profiles, reflecting the system's significance and usage across various segments of the population. Commuters utilizing the tramways include daily passengers, often from lower to middle-income groups, relying on the affordable fares and extensive network to connect residential areas with commercial hubs and educational institutions. Students form a significant portion of these commuters, appreciating the cost-effective and reliable transport option the tram system provides.

Beyond daily commuters, tourists and heritage enthusiasts are drawn to the Kolkata tramways, viewing them not just as a mode of transportation but as a cultural experience. This user segment values the tramways for their historical charm, exploring the city's heritage through leisurely tram rides along iconic routes. Tourists also contribute to the tram system's revenue through special tour packages and sightseeing opportunities, highlighting its dual role as a transport service and a tourist attraction.

Moreover, the Kolkata tramways attract environmentally conscious individuals and advocates of sustainable mobility. For this user segment, trams represent a greener alternative to traditional vehicles, running on electricity and emitting lower carbon emissions per passenger compared to other modes of transport. They view supporting and using the tram system to promote eco-friendly transportation practices and reduce their carbon footprint.

In essence, the user characteristic of the Kolkata tramways encompasses a blend of daily commuters, tourists, heritage enthusiasts, and environmentally conscious individuals, each contributing to the system's cultural, economic, and environmental significance in the city's urban fabric.

The survey results revealed a gender skew, with males comprising a slightly larger portion of respondents at 55.6% compared to females at 44.4% (Figure 13). Interestingly, the data also depicted a clear trend in age distribution. The most well-represented age group was 19 to 35 years old, constituting a significant 58.10% of all respondents. This was followed by a steady decline in participation across increasing age groups. The 36- to 50-year-olds accounted for 18.60%, while those between 51 and 65 years old made up 11.60%. Representation dipped further for

individuals below 18 (6.90%) and above 65 (4.80%) (Figure 14). This breakdown provides valuable insights into the demographic makeup of the survey's participants.

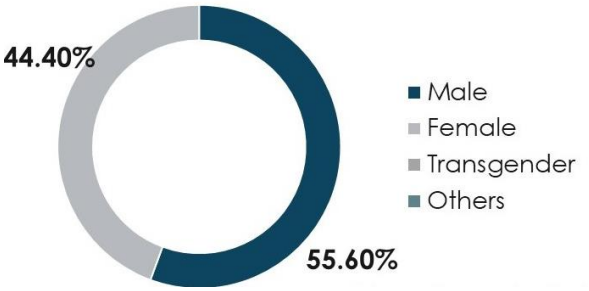


Figure 13: Gender of Users
Source: Primary Survey by Author

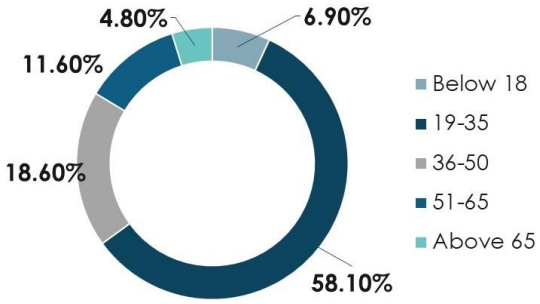


Figure 14: Age of Users
Source: Primary Survey by Author

Taking a closer look at the survey's occupational breakdown (Figure 15), it becomes evident that students comprised the largest group of respondents, accounting for nearly half (48.70%) of all participants. This suggests a significant focus on the younger population within the survey. Following this, the private sector emerged as the second most common employment category, with 22.20% of respondents identifying as private service workers. Business ownership came in at a notable 10.50%, highlighting an entrepreneurial spirit among a segment of the surveyed population. Homemakers constituted 7.40%, while government positions accounted for 5.60%. It is worth noting the survey also captured a small percentage of retired individuals (3.50%) and unemployed persons (2.10%). This comprehensive occupational distribution offers a window into the professional landscape of the survey's respondent pool.

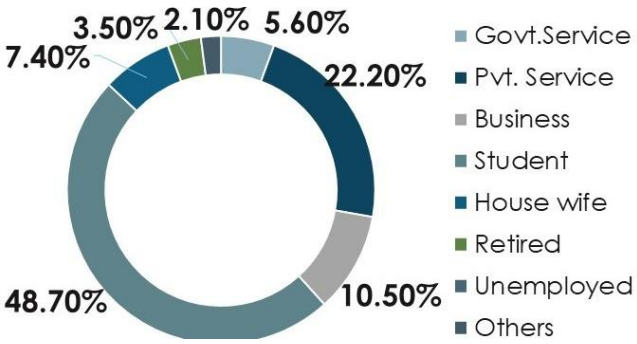


Figure 15: Occupation of Users
Source: Primary Survey by Author

Unveiling the motivations behind the travel undertaken by the survey's respondents (Figure 16), we see a clear emphasis on leisure pursuits. Recreational travel topped the list, with a significant 35.98% of respondents indicating this as their primary purpose. This suggests a strong desire for relaxation and exploration among the participant pool. Educational travel followed closely behind, capturing the interest of 25.60% of respondents, highlighting a thirst for knowledge and personal growth experiences. Work-related travel held a respectable position at 16.84%, showcasing the importance of business trips and professional mobility. Interestingly, business travel itself stood at 6.80%, distinct from general work travel. This might indicate dedicated business trips separate from broader work-related movement. Tourist travel, focused on sightseeing and cultural immersion, accounted for 5.78% of respondents. Social gatherings and events motivated travel for 5.50% of participants, while religious pilgrimages or spiritual journeys drew in 3.50%. This breakdown offers a fascinating glimpse into the diverse reasons people embark on travel adventures.

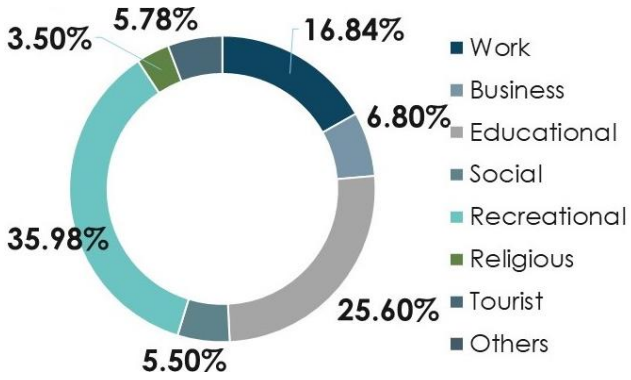
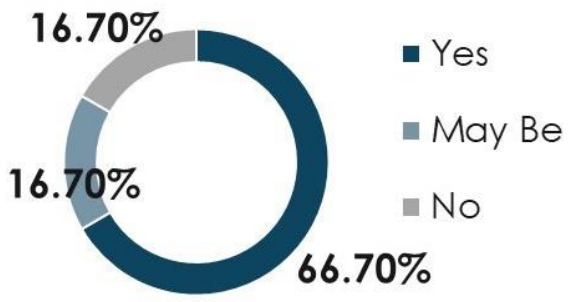


Figure 16: Purpose of Travel of Users
Source: Primary Survey by Author

Public opinion regarding the iconic trams of Kolkata leans heavily towards their preservation and expansion (Figure 17). A resounding 66.70% of respondents voiced their support for trams operating on new routes, showcasing a desire to see this cultural symbol extend its reach within the city. This enthusiasm is further bolstered by the overwhelming 88.90% who believe trams should remain a fixture on Kolkata's streets. These findings highlight the trams' significance as a heritage element (a huge number of respondents felt they were a heritage component) and their continued relevance as a public transportation mode (an important public

transit mode). While a small minority (16.70% and 11.10% respectively) expressed opposition to new tram routes or complete removal of existing ones (Figure 17), the dominant sentiment clearly advocates for the trams' enduring role in the city's identity and transportation landscape.

"Tram should operational in new routes also in Kolkata?"



"Tram should remove from Kolkata?"

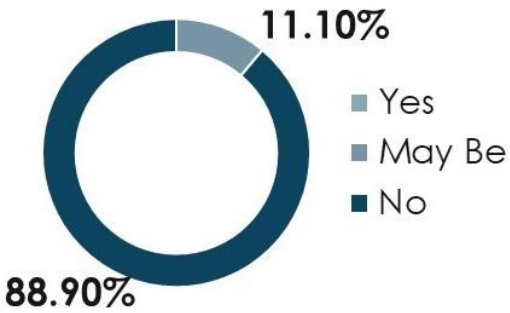


Figure 17: Opinion of respondents regarding importance of trams
Source: Primary Survey by Author

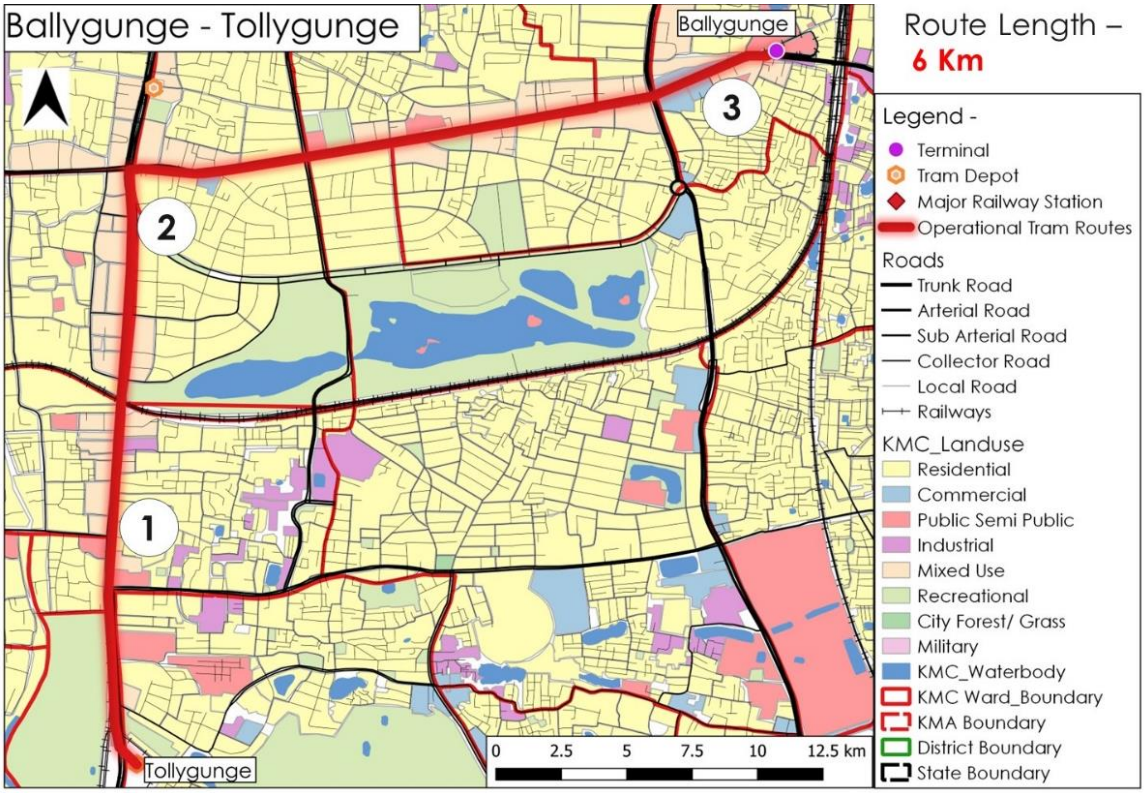
5.5 Analysis to examine the existing conditions of tram routes

To understand the existing conditions and problems of the tram routes of the city, primary survey was conducted through detailed site observation and photo and video analysis. The right of way along the tram routes was mapped to understand if congestion on road was being caused due to narrowness of roads. To further understand the congestion situation, traffic survey was conducted at three points along the three operational tram routes. The land use along the tram routes was also mapped via primary survey and mapping of heritage and tourist places, educational institutions and commercial zones was done to understand the purpose of travel along the routes.

5.5.1 Route – Ballygunge to Tollygunge

A trip on the Ballygunge to Tollygunge tram route in Kolkata is a journey through the heart of a dynamic city. Winding its way for 6 kilometres through a vibrant and bustling area, the tram offers a unique perspective on Kolkata's diverse neighbourhoods and urban landscape (Map 6). The starting point in Ballygunge pulsates with life. This residential and commercial hub is known for its bustling

markets, delectable eateries, and esteemed cultural institutions. Here, the tram becomes an integral part of the daily rhythm, ferrying residents, students, and professionals on their errands and commutes. As the tram glides along its tracks, the right-of-way varies between 25 and 39 meters (Figure 18), offering glimpses of shops, homes, and the occasional heritage building, creating a dynamic tapestry of the city's soul.



Map 6: Route Ballygunge to Tollygunge
Source: Author Generated

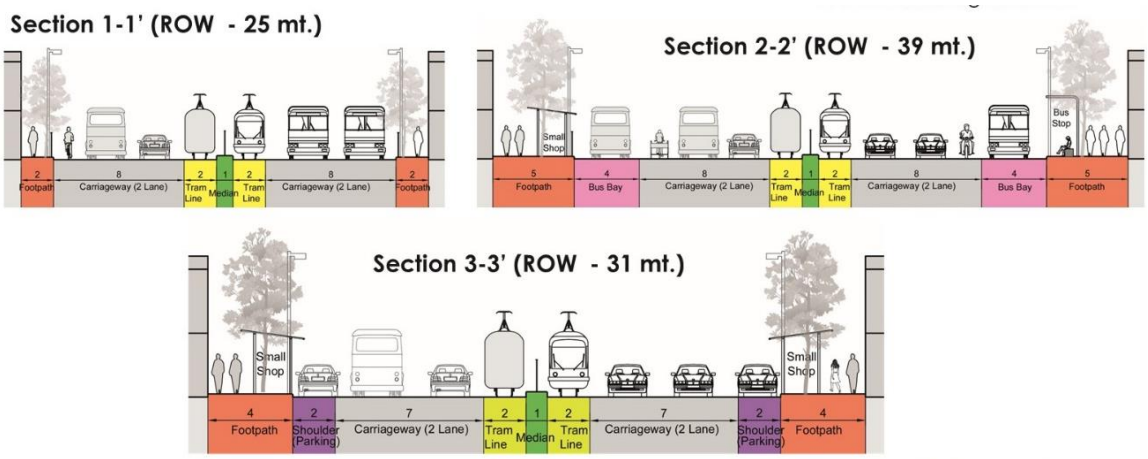
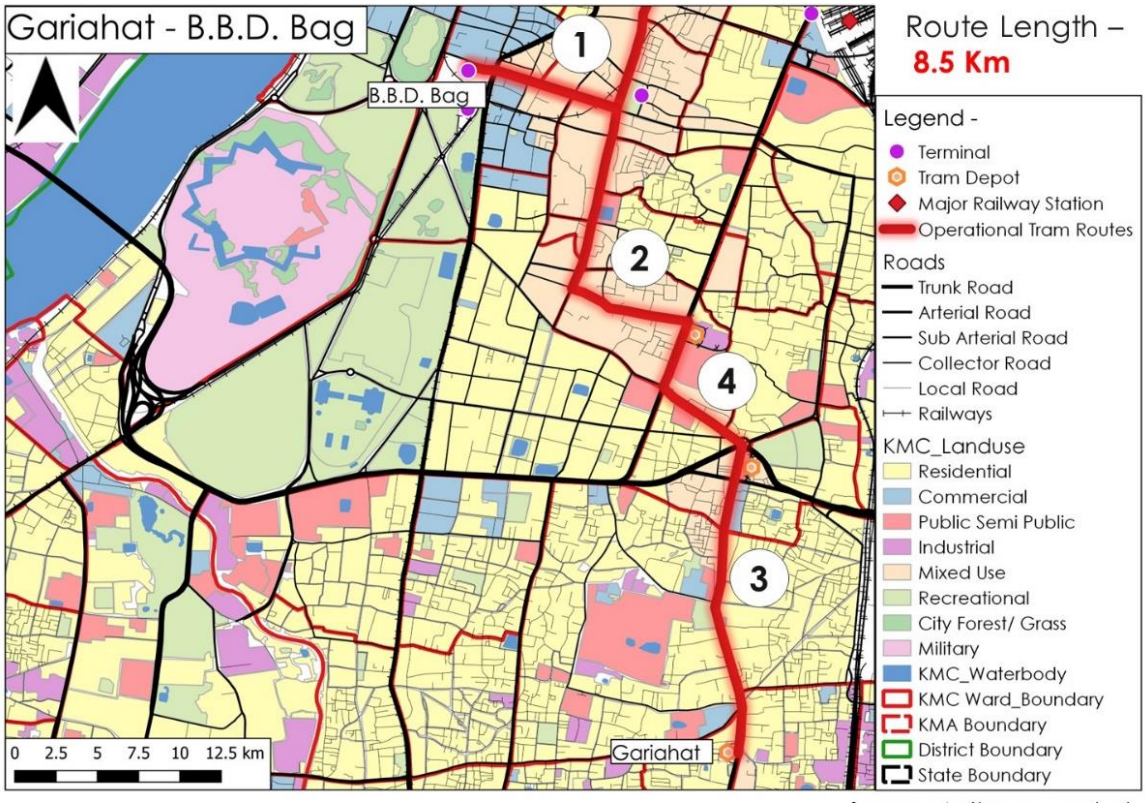


Figure 18: Cross Section at Route Ballygunge to Tollygunge
Source: Author Generated

Figure 19: Site Images at Route Ballygunge to Tollygunge
Source: Primary Survey by Author

5.5.2 Route – Gariahat to B.B.D Bag

Embark on a historical and cultural expedition through Kolkata aboard the tram route stretching from Gariahat to B.B.D. Bag (Dalhousie Square). This 8.5-kilometer journey unfolds like a living timeline, seamlessly blending modern commerce with the city's heritage charm (Map 7). Gariahat, the bustling starting point, pulsates with energy. Here, the tram becomes a familiar sight, transporting residents, shoppers, students, and even tourists seeking a unique perspective of the city. As the tram meanders through the streets, the right-of-way varies between 15 and 37 meters (Figure 20), offering glimpses of vibrant markets, trendy boutiques, and established eateries that define Gariahat's character. As the journey progresses, the landscape transforms, revealing Kolkata's rich past. Passengers become immersed in the city's architectural tapestry, where colonial-era buildings, grand government offices, and historical landmarks stand tall alongside modern commercial complexes. This route through B.B.D. Bag, the heart of Kolkata's business district, is a testament to the city's evolution, making it a captivating experience for tram riders.



Map 7: Route Gariahat to B.B.D Bag
Source: Author Generated

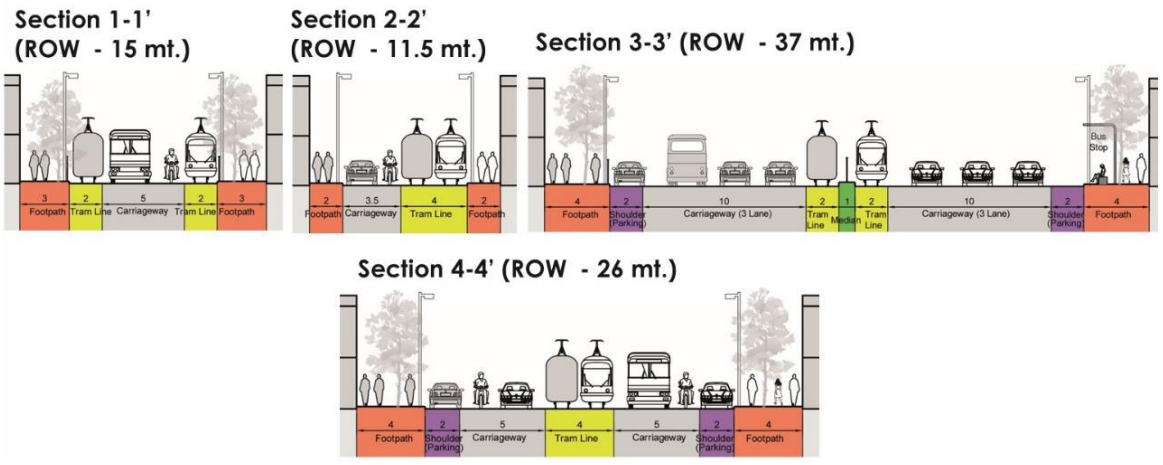
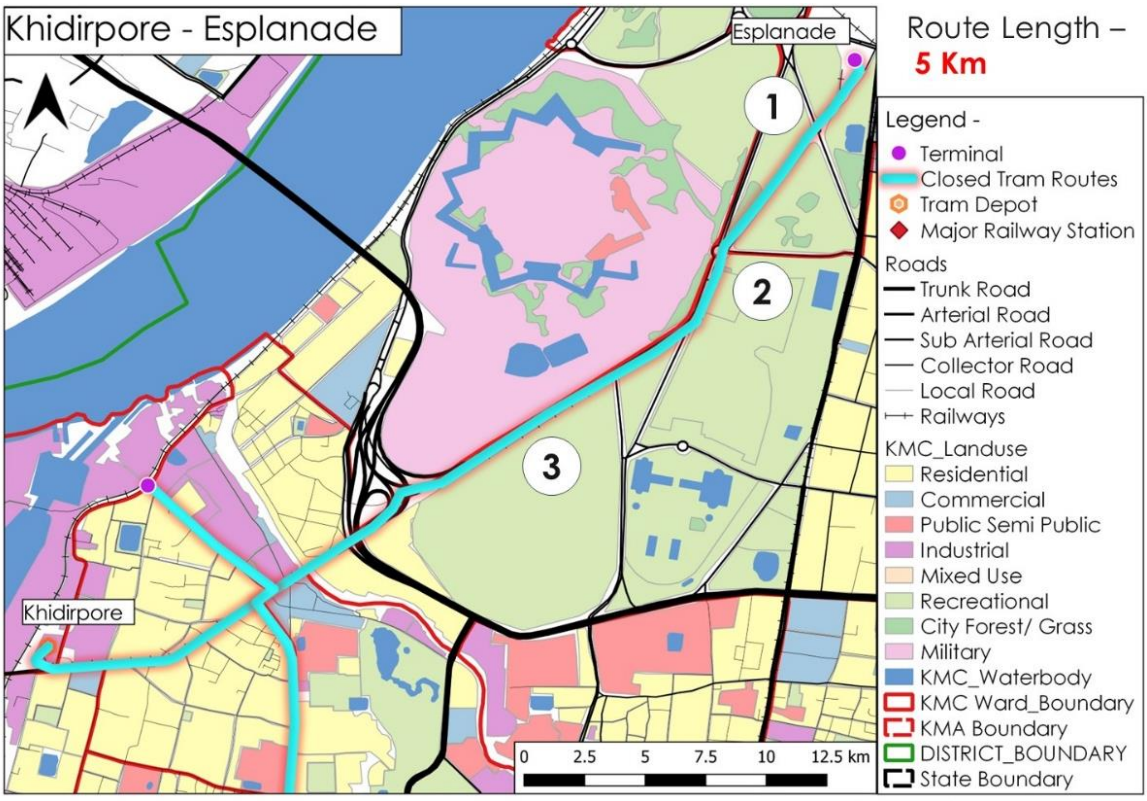


Figure 20: Cross Section at Route Gariahat to B.B.D Bag
Source: Author Generated

Figure 21: Site Images at Route Gariahat to B.B.D Bag
Source: Primary Survey by Author

5.5.3 Route – Khidirpore to Esplanade

Immerse yourself in the vibrant tapestry of Kolkata with a tram ride from Khidirpore to Esplanade. This 5-kilometer journey unfolds like a living diorama, showcasing the city's diverse neighbourhoods, cultural landmarks, and bustling commercial districts (Map 8). As the tram winds its way through the streets, the right-of-way varies between 24 and 45 meters (Figure 22), offering ever-changing glimpses into the heart of Kolkata. The route acts as a time capsule, transporting you through various eras of the city's history. Passengers become witnesses to the city's evolution, with colonial-era structures standing proudly alongside modern establishments. This captivating journey caters not only to residents but also to tourists and leisure travellers seeking a unique perspective on Kolkata's essence. For them, the tram ride becomes an unforgettable exploration of the city's cultural heritage and bustling activity. It is a front-row seat to the daily rhythm of life in Kolkata, offering a chance to experience the city's soul firsthand.



Map 8: Route Khidirpore to Esplanade
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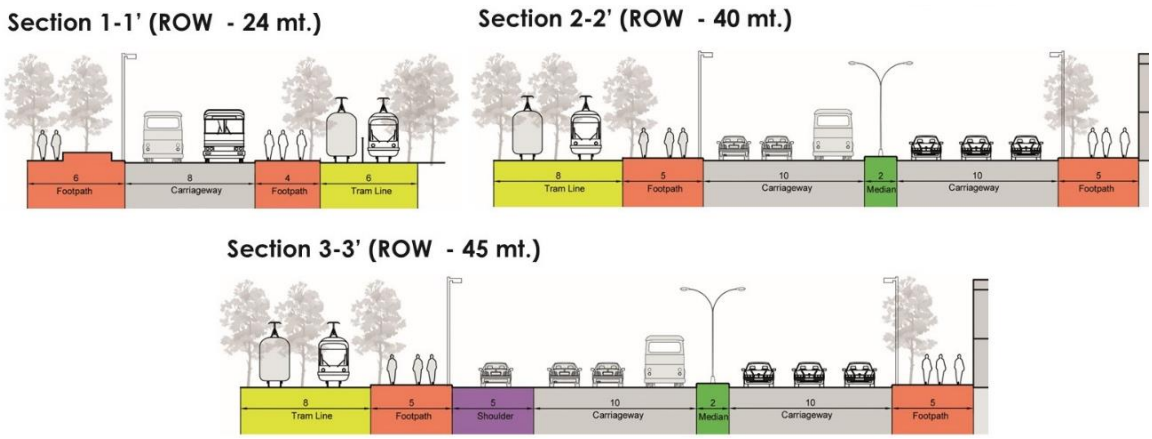


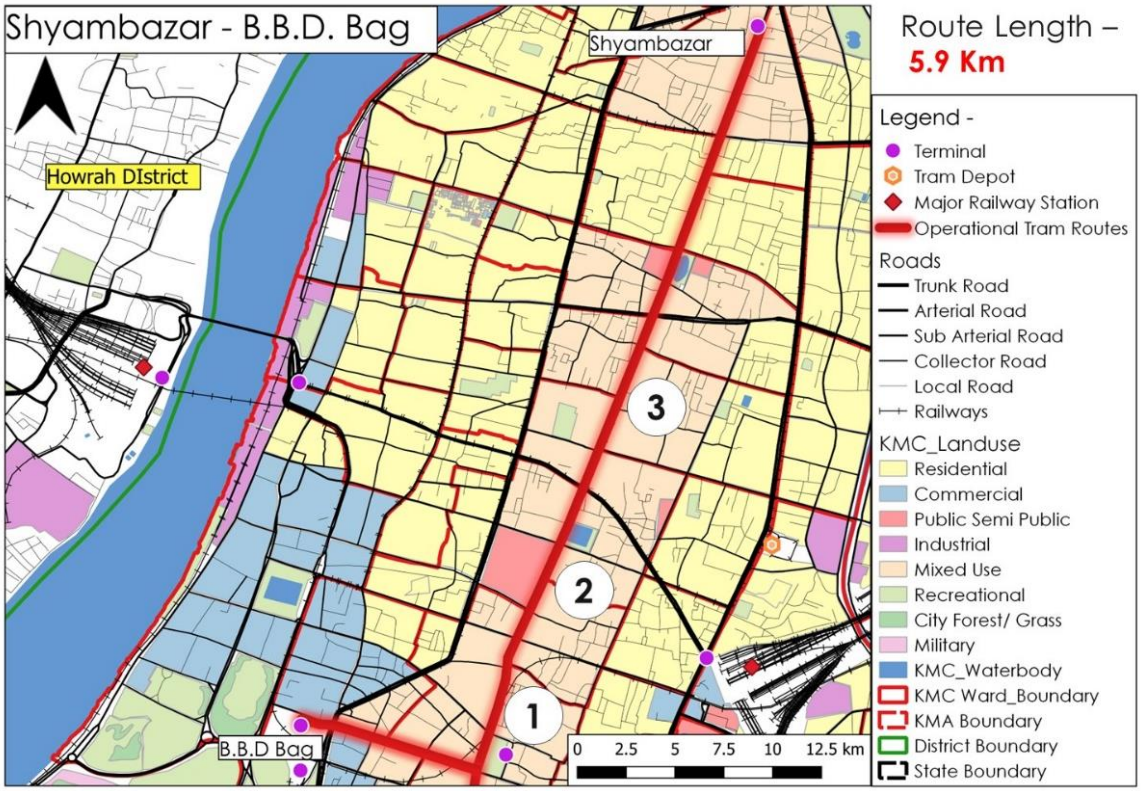
Figure 22: Cross Section at Route Khidirpore to Esplanade
Source: Author Generated

Figure 23: Site Images at Route Khidirpore to Esplanade
Source: Primary Survey by Author

5.5.4 Route – Shyambazar to B.B.D Bag

Hop aboard a piece of Kolkata's history with a tram ride from Shyambazar to B.B.D. Bag. This 5.9-kilometer journey is not just a commute (Map 9); it is a time-traveling adventure through the city's vibrant soul. The starting point in Shyambazar explodes with energy. Bustling markets and iconic cultural landmarks like the Marble Palace set the stage for a captivating adventure. As the tram glides along its tracks, with a right-of-way varying between 17 and 25 meters (Figure 24), iconic sights unfold. College Street, a haven for bookworms, whizzes by, followed by the majestic Victoria Memorial, a monument that whispers tales of a bygone era. Passengers become part of a living tapestry, the sights, sounds, and smells reflecting the city's diverse character. The tram acts as a bridge between eras, contrasting the old-world charm of heritage buildings with the modern pulse of the city. The journey reaches its climax in B.B.D. Bag, Kolkata's beating commercial heart. Here, towering government offices and financial institutions stand tall beside historical landmarks, etching a final image of the city's rich past and promising

future. By the time you disembark, you will have experienced a slice of Kolkata's essence, a captivating blend of history, culture, and modern dynamism.



Map 9: Route Shyambazar to B.B.D Bag
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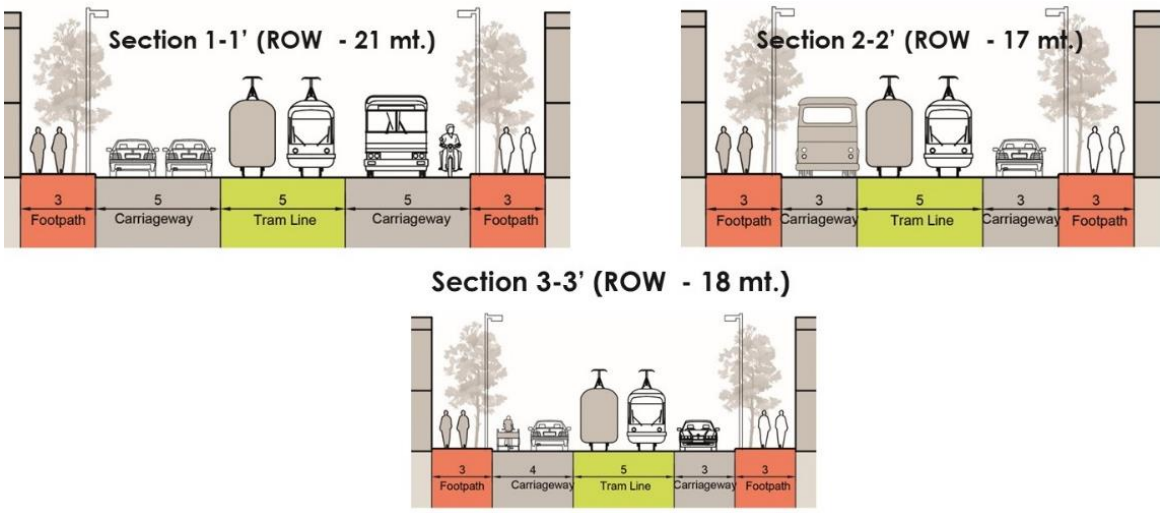


Figure 24: Cross Section at Route Shyambazar to B.B.D Bag
Source: Author Generated

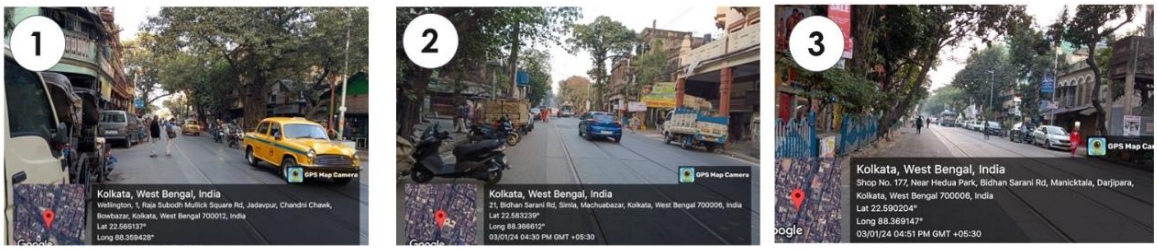


Figure 25: Site Images at Route Shyambazar to B.B.D Bag
Source: Primary Survey by Author

5.6 Application of Multi-Criteria Decision-Making Techniques to Evaluate the Heritage Sites

Evaluating heritage structures plays a crucial role in understanding their historical, architectural, and cultural significance. This process acts as a compass, guiding the prioritization of conservation efforts, allocation of resources, and the development of effective preservation policies. Evaluating built heritage necessitates a well-defined set of parameters, meticulously crafted based on existing research and the specific context of the city. A comprehensive explanation of these decision criteria, including their sub-parameters and assigned weights, along with the resulting analysis forms the cornerstone of this process. This meticulous evaluation ensures that heritage sites are not only recognized for their value but also receive the necessary care and attention for their continued preservation.

Initiating the AHP framework, we begin by defining the goal, assessing, and ranking 121 heritage sites. This meticulous process hinges on a structured hierarchy comprising five main parameters and ten sub-parameters. Each heritage sites will be meticulously evaluated against each sub-parameters within its respective main parameter. Subsequently, evaluations will be aggregated within each main criterion, ultimately leading to the derivation of final weights for each site. The four pillars of this evaluation framework are discussed below.

i. Historical Significance: P1

Historical value forms the bedrock of the very concept of heritage. It encompasses the multifaceted tapestry of a place's past, encompassing the evolution of its community, artistic expressions, architectural styles, and aesthetic sensibilities. As Australia ICOMOS (2013) aptly points out, a heritage asset's ability to convey a

connection to the past lies at the core of its meaning and significance. This historical value manifests in diverse ways, ranging from the structure's construction period to its association with prominent individuals, pivotal events, or influential groups of people. By delving into these historical layers, we gain a deeper understanding of the structure's role in shaping the community's narrative and its enduring contribution to the collective memory of a place.

Age of structure: P11

The age of a structure serves as a fundamental indicator of the historical depth it embodies, as emphasized by Thorold (2005). This principle holds true in the context of Kolkata, where a treasure trove of architectural marvels stands testament to the city's rich and layered past. From the late 16th to the 19th centuries, Kolkata witnessed the rise and fall of various empires, each leaving behind their distinct mark on the city's landscape. The impressive monuments constructed by the British Colonials, Bengal Nawabs, Zamindars, Delhi Sultanate rulers, Nizam Shahs, and Mughals offer a tangible glimpse into these diverse historical periods. Analysing the age of these structures allows us to gauge the extent of historical information they hold, providing valuable insights into the city's evolution and the socio-political forces that shaped its unique character.

Historical Importance: P12

Beyond mere age, a heritage structure's historical significance is significantly enhanced by its association with notable individuals, pivotal events, or influential groups that left their mark on the local, regional, or even national landscape, as emphasized by Thorold (2005). Such connections imbue the structure with a deeper layer of meaning, transforming it from a physical entity into a tangible narrative of the past. A building that served as the headquarters for a revolutionary movement, a palace that housed a legendary ruler, or a monument commemorating a significant historical event transcends its physical form to become a powerful symbol of the forces that shaped the course of history. By understanding these associations, we gain a richer perspective on the structure's contribution to the broader historical narrative and its role in shaping the collective memory of a community or nation.

ii. Architectural Significance: P2

Beyond the realm of historical significance, the architectural value of a heritage structure delves into its visual essence and the design qualities that set it apart. As Australia ICOMOS (2013) aptly points out, this value encompasses the structure's style of construction, its unique design elements, the materials employed in its creation, and the level of creative and technical ingenuity it embodies. A heritage structure might showcase a distinct architectural style, perhaps representing a specific era or region, or it might possess a unique and innovative design that deviates from the norm. The materials employed in its construction, whether traditional or cutting-edge, can also contribute to its architectural value. Ultimately, it is the high degree of creative and technical achievement exhibited in the structure that elevates it from the ordinary to the extraordinary, solidifying its place as a valuable piece of architectural heritage. Analyzing these various aspects allows us to appreciate the structure's aesthetic qualities, its contribution to the evolution of architectural styles, and its embodiment of the technical prowess of its creators.

Aesthetic value: P21

Aesthetic value delves into the intricate details that breathe life into a particular architectural style, transforming it from a blueprint into a visually captivating entity. The meticulous detailing on windows, balconies, verandas, and facades transcends mere functionality, imbuing the structure with a unique identity and artistic expression. Each ruling regime in a city's history often leaves behind its own distinctive architectural legacy, evident in the impressive monuments that dot the landscape. These structures showcase the aesthetic sensibilities of their creators, employing intricate design elements that reflect the prevailing artistic trends and cultural influences of their respective eras. From the delicate ornamentation adorning a Mughal palace to the clean lines of a colonial building, these aesthetic details form a visual language that narrates the story of a place's artistic evolution and the enduring impact of different cultures on its architectural landscape. By appreciating these intricate details, we gain a deeper understanding of the aesthetic values that shaped the city’s-built environment and the artistic legacy left behind by its various rulers and inhabitants.

Construction Style: P22

A heritage structure's architectural value transcends mere aesthetics; it serves as a tangible embodiment of the prevalent architectural styles and design principles of different reigns. Analysing these structures reveals a fascinating tapestry of visual elements, design features, construction techniques, and material usage that were characteristic of specific historical periods. Each ruling regime often left its unique mark on the city's-built environment, evident in the structures that showcase typical design features, ornamentation, and construction styles associated with their era. By meticulously examining these elements, we can trace the evolution of architectural styles across different reigns, from the grand arches and domes of Mughal architecture to the intricate details and ornamentation of colonial buildings. This analysis allows us to appreciate the distinct design language employed by each regime, reflecting the cultural influences and artistic sensibilities that shaped their architectural legacy. Ultimately, understanding how a structure embodies the visual elements and design principles of a particular reign enriches our appreciation for its architectural value and its role in chronicling the city's architectural evolution.

iii. Socio-Economic Significance: P3

Heritage structures transcend their physical presence to play a significant role in shaping and creating the cultural and social identity of a society. They serve as tangible links to the past, embodying the values, traditions, and artistic expressions of bygone eras. By preserving these structures, we safeguard the cultural heritage that forms the bedrock of a community's sense of belonging and identity.

Community Association: P31

Heritage structures extend beyond their physical presence to play a crucial role in shaping and defining the social identity of a local community. They often serve as functional and symbolic landmarks, deeply woven into the fabric of neighbourhood life. A strong association with a particular neighbourhood imbues a heritage structure with a unique significance, transforming it from a historical artifact into an integral part of the community's present and future. This functional role can manifest in various ways, from providing a venue for social gatherings and cultural

events to serving as a point of reference and orientation within the neighbourhood. Assessing the social significance of a heritage structure requires evaluating its level of integration into community life, its symbolic meaning within the local context, and its potential to foster a sense of belonging and shared identity among residents. By prioritizing structures with a strong connection to their neighbourhoods, we ensure that conservation efforts not only safeguard historical treasures but also contribute to the ongoing social and cultural well-being of the community.

Tourism potential: P32

Evaluating a heritage structure's potential as a tourist destination holds significant weight within the framework of conservation efforts. By attracting visitors, these structures can be transformed into vibrant hubs that contribute to the community's economic development through heritage tourism. This economic boost can ripple through the local economy, creating employment opportunities in sectors like hospitality, transportation, and retail. Additionally, heritage tourism can act as a catalyst for promoting local arts and cultural activities, further enriching the community's social fabric. By strategically positioning heritage structures as tourist destinations, we unlock their potential to generate revenue that can be reinvested into their ongoing conservation and maintenance. This sustainable cycle ensures that these precious structures are not only preserved for future generations but also contribute meaningfully to the community's present-day economic and social well-being.

iv. Integrity: P4

A crucial aspect of evaluating a heritage structure lies in assessing its integrity, which refers to the preservation of its critical design elements without any significant additions or alterations. This integrity encompasses both the structural and physical condition of the building. Ideally, the structure should retain its original design features, materials, and overall form, as these elements are the very essence of its historical and architectural significance. Any major modifications or additions can compromise the structure's authenticity and diminish its ability to tell the story of its past.

Condition of structure: P41

A thorough evaluation of a heritage structure necessitates a meticulous examination of its overall structural and physical condition. This assessment delves into the building's structural integrity, ensuring its stability and ability to withstand environmental factors and potential hazards. It involves analysing the foundation, load-bearing elements, and overall framework to identify any weaknesses or potential areas of concern. Additionally, the physical condition of the structure is evaluated, considering the presence of cracks, decay, water damage, or other signs of deterioration. This includes examining the condition of the exterior and interior finishes, roofing materials, and any decorative elements. By meticulously assessing both the structural and physical condition, we gain a comprehensive understanding of the building's current state and its potential vulnerability to further damage. This information is crucial for determining the necessary conservation measures and prioritizing restoration efforts to ensure the longevity of these valuable heritage structures.

Functionality: P42

An ideal scenario for a heritage structure is the continued use of its original function. This ensures the preservation of its historical purpose and its ongoing integration into the community's life. However, in certain cases, an alternative use might be necessary due to changing societal needs or the structure's original function becoming obsolete. When considering such adaptations, it is crucial that the alternative use respects and adapts the original characteristics and elements of the structure. This ensures that the heritage value is not compromised, and the building retains its connection to its historical context. Additionally, the chosen new use should be compatible with the present land-use of the surrounding area. Integrating the heritage structure seamlessly into the existing neighbourhood or street fosters a sense of continuity and prevents it from becoming an isolated relic of the past. By striking a balance between respecting the original function and allowing for appropriate adaptations, we can ensure the continued relevance and vitality of heritage structures within the evolving fabric of the community.

v. Proximity: P5

Proximity plays a significant role in the evaluation of heritage structures, particularly when considering their potential as tourist destinations. Ideally, heritage sites should be situated within walkable distance of existing tram lines. This accessibility factor directly impacts the ease and convenience with which visitors can reach these cultural treasures. A well-connected heritage site, accessible via public transportation, encourages sustainable tourism practices and reduces reliance on private vehicles, contributing to a more environmentally friendly visitor experience.

Distance from existing tram line: P51

Further enhancing the accessibility factor, a desirable characteristic for heritage structures with tourism potential is their proximity to existing tram lines. Ideally, these sites should be situated within a comfortable walking distance, approximately 500 meters, from a tram stop. This strategic placement offers several advantages.

Distance from existing tram Depot/Terminal: P52

Accessibility plays a crucial role in maximizing the potential of heritage sites as tourist destinations. Ideally, these sites should be situated near existing tram terminals or depots. This strategic positioning offers numerous advantages. Firstly, it significantly enhances the ease and convenience with which visitors can reach these cultural treasures. By being within a reasonable distance of a tram terminal, visitors can easily utilize public transportation, eliminating the need for private vehicles and promoting sustainable tourism practices. Additionally, proximity to a tram terminal fosters a sense of connection between the heritage site and the broader transportation network, making it a more accessible and integrated part of the urban landscape. This convenient access not only encourages visitation but also allows visitors to seamlessly explore the surrounding area, potentially discovering other cultural attractions or local businesses along the way. Ultimately, ensuring a proximity to tram terminals or depots contributes to a more enjoyable and environmentally friendly visitor experience, maximizing the potential of heritage sites to attract tourists and contribute to the local economy.

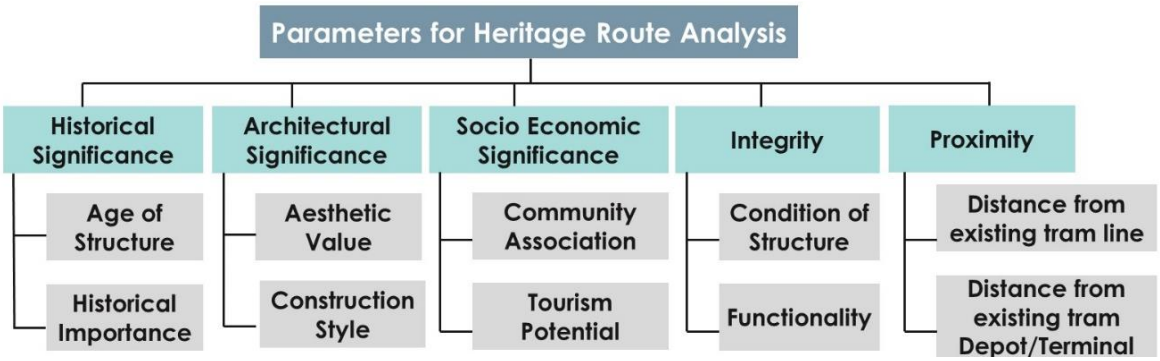


Figure 26: Hierarchical Structure of Parameters for Heritage route Analysis
Source: Author Generated

5.6.1 Grey Relational Analysis (GRA) for ranking of Parameters

Grey Relational Analysis (GRA) provides a valuable tool for ranking parameters based on the subjective judgments of multiple experts. In this context, we have four experts who have ranked a set of parameters related to heritage sites evaluation. The list of experts is listed below.

1. Dr. Utpal Roy (Associate Professor), Dept. of Geography, University of Calcutta
2. Ar. Sumon Gupta (Architect & Planner), Aakriti, Kolkata
3. Subham Pramanick, (Senior Research Fellow) Dept. of Geography, Ballygunge Science College
4. Indranil Maity (Research Assistant), Dept. of Geography, Ballygunge Science College

GRA offers a systematic approach to combine these individual rankings and arrive at a definitive ranking that reflects the collective expert opinion. Refer (Annexure II) for detailed Calculations.

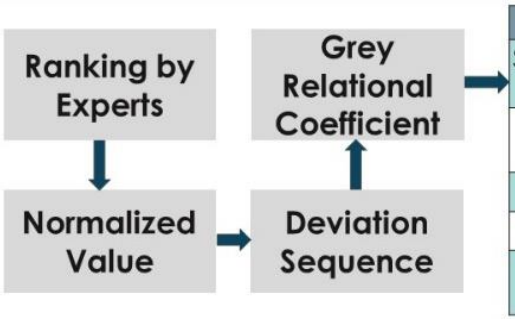
The process involves several key steps (Figure 27):

a. **Normalization:** Individual expert rankings are first normalized to a common scale, typically between 0 and 1, to ensure comparability despite potential variations in scoring systems.
b. **Deviation Sequence:** The deviation between the normalized reference sequence (ideally the "best" parameter) and each individual expert's normalized ranking is calculated.

c. **Grey Relational Coefficient:** This coefficient measures the degree of similarity between the reference sequence and each expert's ranking, considering the calculated deviations.

d. **Grey Relational Grade:** The average of the Grey Relational Coefficients for each parameter across all experts is calculated, providing a single value representing its overall relational degree.

e. **Ranking:** Finally, parameters are ranked based on their Grey Relational Grades, with the highest grade indicating the parameter that most closely aligns with the collective expert opinion.



Parameters	GRG	RANK
Socio Economic Significance	0.5	3
Architectural Significance	0.6833	2
Proximity	0.35	5
Integrity	0.45	4
Historical Significance	0.9167	1

Figure 27: Framework for Grey Relational Analysis
Source: Author Generated

5.6.2 Weightage distribution among Parameters using Rank Sum Method (RSM)

Having established the relative importance of the five main criteria (Historical Significance, Architectural Significance, Socio Economic Significance, Proximity, and Integrity) through ranking, now proceed to the Rank Sum Method (RSM) for assigning specific weights to each criterion. RSM provides a systematic approach to distribute weightage based on the previously determined ranks. By analysing the ranks assigned to each criterion, RSM calculates a weight that reflects its relative importance within the overall evaluation framework (Table 4).

Table 4: Weightage distribution among parameter using RSM

Rank Sum Method			
Parameter	**Rank**	**Reverse Rank**	**Weightage**
Historical Significance (P1)	1	5	**0.33**
Architectural Significance (P2)	2	4	**0.27**
Socio Economic Significance (P3)	3	3	**0.20**
Integrity (P4)	4	2	**0.13**
Proximity (P5)	5	1	**0.07**
By Using Rank Sum		15	1.00

Source: Author Generated

Now the determination of weights for the five main parameters through the Rank Sum Method, the next step involves distributing these weights further among the sub-criteria nested within each main parameter. As mentioned, this distribution often occurs in an equal manner (Table 5). This means that each sub-parameter under a specific main criterion receives an equal share of the weight assigned to that main parameter.

Table 5: Weightage Distribution among Sub-Parameter

Parameter	Weightage (Parameter)	Sub Parameter	Weightage (Sub Parameter)
Historical Significance (P1)	**0.33**	Age of the Structure (P11)	**0.165**
		Association Involved (P12)	**0.165**
Architectural Significance (P2)	**0.27**	Aesthetic value (P21)	**0.135**
		Construction Style (P22)	**0.135**
Socio Economic Significance (P3)	**0.2**	Community Association (P31)	**0.1**
		Tourism Potential (P32)	**0.1**
Integrity (P4)	**0.13**	Condition of Structure (P41)	**0.065**
		Functionality (P42)	**0.065**
Proximity (P5)	**0.07**	Distance from existing tram line (P51)	**0.035**
		Distance from existing tram Depot/Terminal (P52)	**0.035**

Source: Author Generated

5.6.3 Rating of Heritage Sites for 8 Sub – Parameter

To comprehensively evaluate each heritage structure, ratings were assigned to each sub-parameter within its respective main parameter (Table 6). A straightforward rating scale was employed, ranging from "Excellent" (1.00) to "Very Poor" (0.00), with intermediate categories of "Good" (0.75), "Fair" (0.50), and "Poor" (0.25). This standardized scale facilitates easy comparison and avoids complexities in the evaluation process. The rating process itself relied on a combination of methods: visual surveys, local interviews with knowledgeable individuals, and analysis of secondary data related to the specific heritage structure.

Table 6: Rating Classification of Sub-Parameter

Rating of Built Heritage (5 – Likert Scale)						
Sl. No.	Sub - Parameter	Very Good (1.00)	Good (0.75)	Fair (0.50)	Poor (0.25)	Very Poor (0.00)
1	Age of the Structure (P11)	1700-1800	1800-1900	1900-1990	Post 1990	None
2	Association Involved (P12)	International	National	Regional	Local	None
3	Aesthetic value (P21)	Exceptional Architectural Detail	Notable Style of Architecture	Average Detailing	Poor Detailing	Absence of details
4	Style of Construction (P22)	Unique style	Well designed & notable design	Absence of Notable style	Poorly designed	Not well designed, unique and notable
5	Community Association (P31)	The structure has a solid historical association with public use	The structure has a strong historical association However, the structure no longer serves as an essential part of the community	The structure has a limited historical association with the neighborhood	The local community knows the structure	No community association in terms of its function or age.
6	Tourism Potential (P32)	Internationally Important	Nationally Impprtant	Regionally Important	Locally Important	Has potential for tourist destination
7	Condition of Structure (P41)	No maintenance required	Small amount restoration required	It needs quite a bit of work	Extensive repairs and restoration required	Not viable to retain the property
8	Functionality (P42)	The structure has maintained its original function	Adaptive reuse	function has changed	function completely changed	Structure is in abandoned state
9	Distance from existing tram line (P51)	(0-5) Km	(6-10) Km.	(11-15) Km.	(16-20) Km.	More than 20 Km.
10	Distance from existing tram Depot/Terminal (P52)	(0-10) Km	(11-20) Km	(21-30) Km	(31-40) Km	More than 40 Km

Source: Author Generated

5.6.4 Estimation of Score of Heritage Sites using Weighted Sum Method

To get the rank of all heritage buildings, the weighted sum method is used to calculate each structure's score. The WSM score of the heritage building is calculated by using the following equation.

$$Pi^{\text{WSM Score}} = \sum w_i \, x \, pi$$

Where wi is the relative weight of criterion or sub-criterion, and pi is the performance value of each structure when it is evaluated in terms of criterion or sub-criterion Ci. Then Pi is multiplied by priority weight of respective main criteria and final score is summation of these values. Refer (Annexure I) for detailed Ranking of all Heritage sites.

The existing Heritage Tourist places are ranked through this method. (Table 7) shows detailed Ranking system of Twenty-Five places in Kolkata.

Table 7: Ranking of Heritage Sites through WSM Method

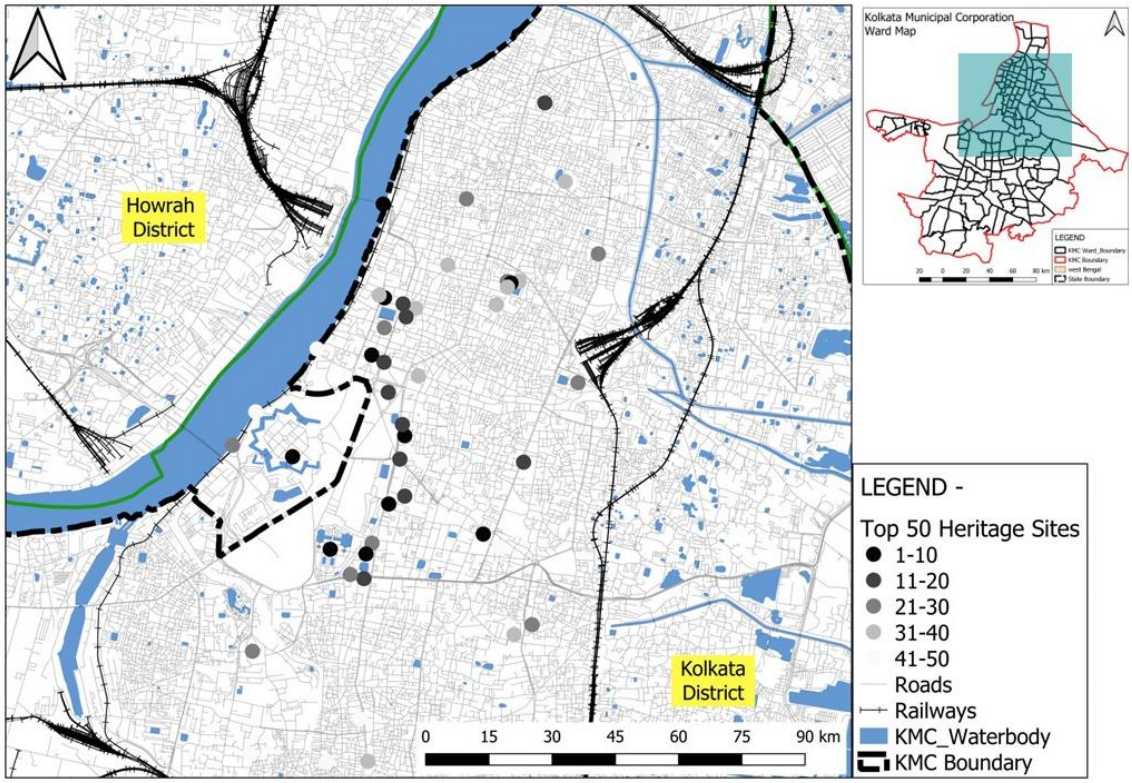
Sl. No.	Main Parameter	Historical Significance (P1)		Architectural Significance (P2)		Socio Economic Significance (P3)		Integrity (P4)		Proximity (P5)		WSM Score	Rank
	Sub Parameter	Age of the Structure (P11)	Association Involved (P12)	Aesthetic value (P21)	Style of Construction (P22)	Community Association (P31)	Tourism Potential (P32)	Condition of Structure (P41)	Functionality (P42)	Distance from existing tram line (P51)	Distance from existing tram Depot/Terminal (P52)		
	Weightage Value	0.165	0.165	0.135	0.135	0.1	0.1	0.065	0.065	0.035	0.035		
1	Victoria Memorial	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95875	**1**
2	Fort William	1.00	1.00	0.75	0.75	1.00	1.00	1.00	0.75	0.50	0.50	0.88125	**9**
3	Howrah Bridge	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.50	0.91625	**4**
4	Princep Ghat	1.00	0.50	0.50	0.75	1.00	1.00	0.75	1.00	0.75	0.75	0.78250	**24**
5	Birla Planetorium	0.50	0.50	1.00	1.00	1.00	1.00	0.25	1.00	0.75	0.75	0.76875	**26**
6	St. Paul Cathedral	1.00	1.00	0.75	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.94875	**2**
7	Shahid Minar	1.00	0.75	0.50	0.75	1.00	0.75	1.00	1.00	1.00	1.00	0.83250	**15**
8	Raj Bhawan	1.00	1.00	1.00	1.00	1.00	0.75	1.00	0.75	0.75	0.75	0.94125	**3**
9	Sovabazar Rajbari	1.00	0.50	0.75	0.75	1.00	1.00	1.00	0.50	0.75	0.50	0.79125	**20**
10	Writers Building	1.00	0.75	1.00	1.00	1.00	0.75	0.75	0.75	1.00	0.75	0.89250	**6**
11	Dhurjoti Bhawan	0.50	0.25	0.50	0.50	0.50	0.50	0.50	0.25	1.00	1.00	0.47750	**96**
12	Gouriya Math	0.75	0.25	0.50	0.50	1.00	0.75	0.75	0.25	0.75	0.75	0.59250	**69**
13	Rameswar Siva Temple	0.50	0.25	0.25	0.00	0.25	0.25	0.75	0.00	0.50	0.50	0.29125	**120**
14	Putul Bari	0.50	0.25	0.50	0.50	0.25	0.25	0.00	0.25	0.50	0.50	0.36000	**111**
15	Star Theatre	1.00	0.25	0.50	0.75	0.75	1.00	0.25	0.25	1.00	1.00	0.65250	**58**
16	Bangiya Sahitya Parishad	1.00	0.50	0.50	0.50	1.00	1.00	0.50	0.75	0.75	0.50	0.70750	**42**
17	Scottish Church Collegiate School	1.00	0.50	0.50	0.50	0.75	1.00	0.75	0.50	1.00	0.75	0.70000	**43**
18	Ahiritolla Ghat	1.00	0.50	0.25	0.00	0.25	0.75	0.50	0.50	0.75	0.50	0.49000	**95**
19	Manik Bose's Ghat	0.75	0.25	0.25	0.00	0.25	0.50	0.25	0.00	0.50	0.50	0.32500	**117**
20	Nimtala Burning Ghat	1.00	0.50	0.25	0.50	0.75	1.00	0.50	0.00	0.50	0.50	0.59125	**72**
21	Durgeswar Siva Temple	1.00	0.25	0.00	0.50	0.25	1.00	0.25	0.00	0.50	0.25	0.44125	**103**
22	Lohia Matri Seva Sadan	1.00	0.25	0.50	0.50	0.75	0.00	0.25	0.50	0.50	0.25	0.49125	**94**
23	Jorasanko Thakurbari	1.00	0.75	0.50	0.75	1.00	0.50	1.00	1.00	1.00	0.50	0.79000	**21**
24	Rabindra Kanan	0.75	0.25	0.00	0.00	0.75	1.00	0.25	0.00	0.50	0.50	0.39125	**107**
25	Christ Church	1.00	0.25	0.50	0.50	0.75	1.00	0.50	0.50	1.00	0.75	0.64250	**60**

Source: Author Generated

5.7 Scenario Development

When selecting heritage corridors in Kolkata, two distinct approaches can be considered:

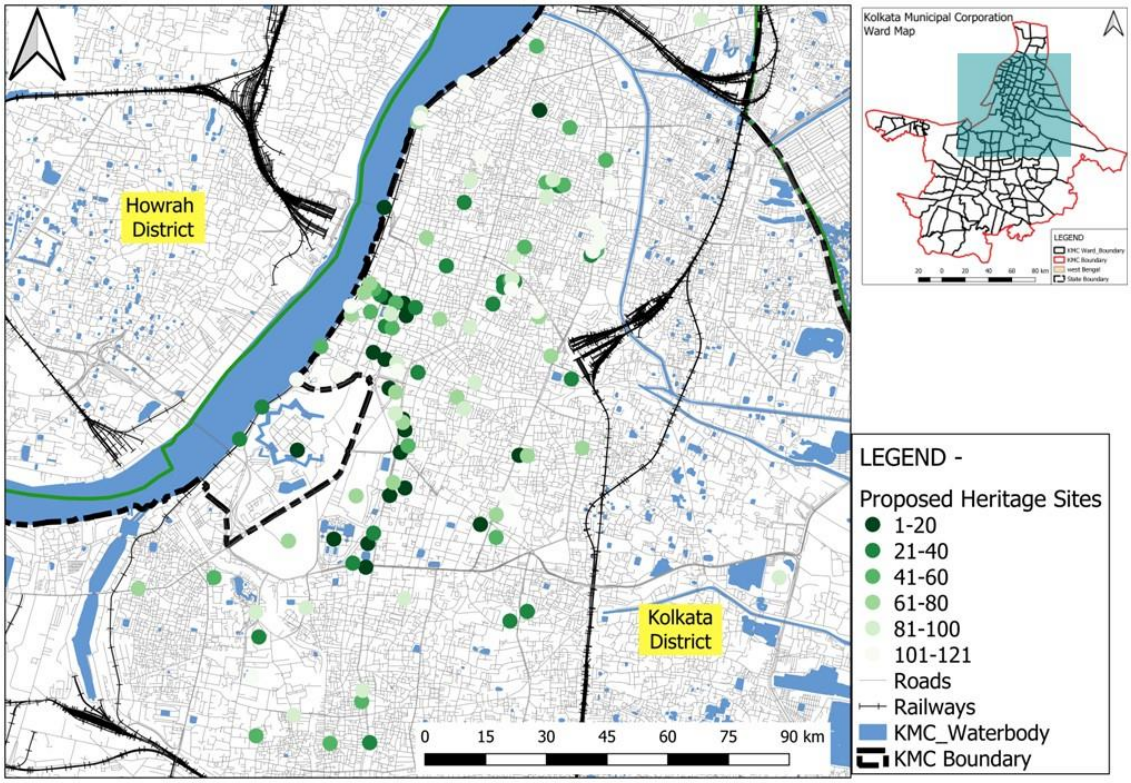
a. **Scenario 1: Focusing on High-Scoring Sites:** This approach prioritizes maximizing the individual scores of the heritage sites within the corridor (Map 10). This prioritizes the inclusion of structures that exhibit exceptional historical, architectural, cultural, and social significance based on the established evaluation criteria. However, this method might not necessarily lead to a geographically cohesive corridor, as high-scoring sites might be scattered across the city and not follow a natural path or existing infrastructure.



Map 10: Top 50 Heritage Sites
Source: Author Generated

b. **Scenario 2: Maximizing Site Coverage:** This approach focuses on incorporating the highest possible number of heritage sites within the designated corridor (Map 11). This strategy aims to create a more comprehensive and geographically defined heritage trail, potentially utilizing a "Hop on Hop off" service for convenient access to multiple sites. While this

method ensures a higher concentration of heritage structures, it might not guarantee that every included site possesses the highest individual score.



Map 11: All Heritage Sites
Source: Author Generated

Building upon the two scenarios for heritage corridor development in Kolkata, we delve further into the evaluation process. Each scenario will be refined into three distinct options, resulting in a total of six potential corridors to be considered. To ensure a comprehensive assessment of these options, a set of eight critical parameters will be employed. These parameters, which will be further elaborated upon, will serve as the foundation for meticulously evaluating each heritage corridor and ultimately selecting the most suitable option. The parameters are shown below:

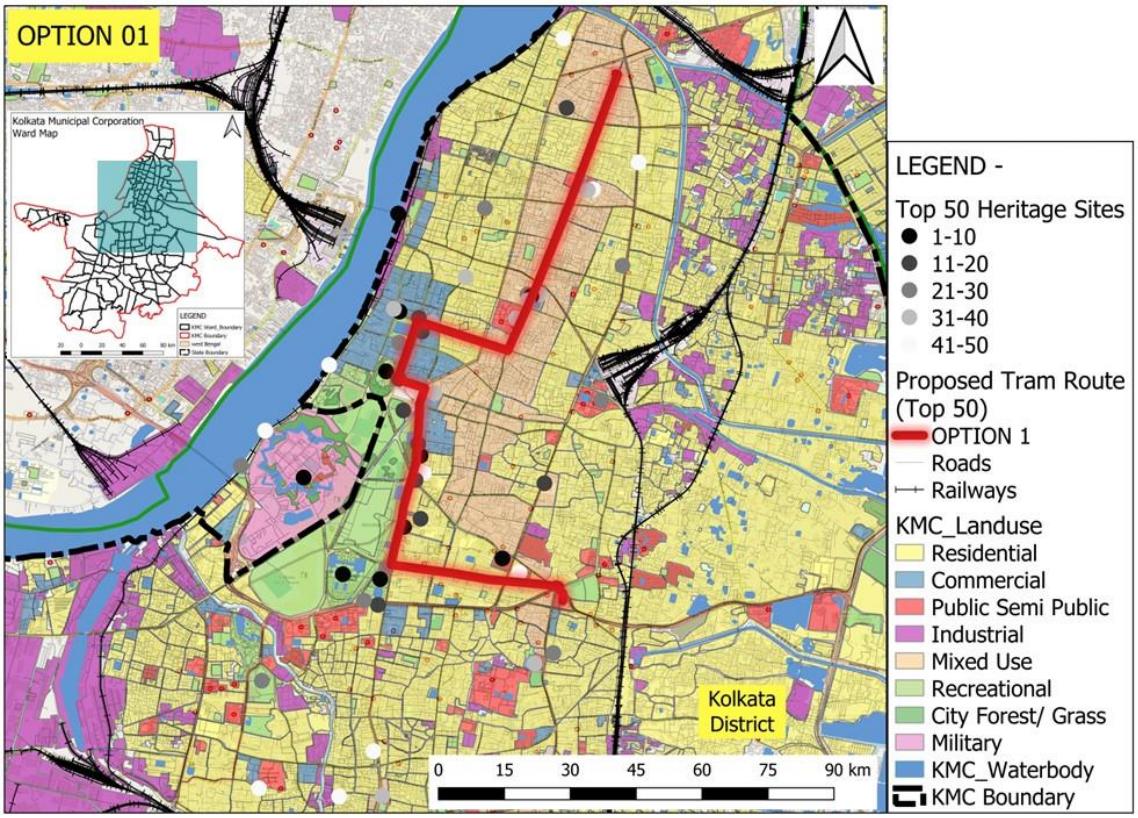
i. Suitable ROW
ii. Percentage of ROW Use
iii. Land Use
iv. Route Length
v. Percentage of route along Metro Corridor
vi. Existing & New Tram Lines

vii. Heritage Site Coverage

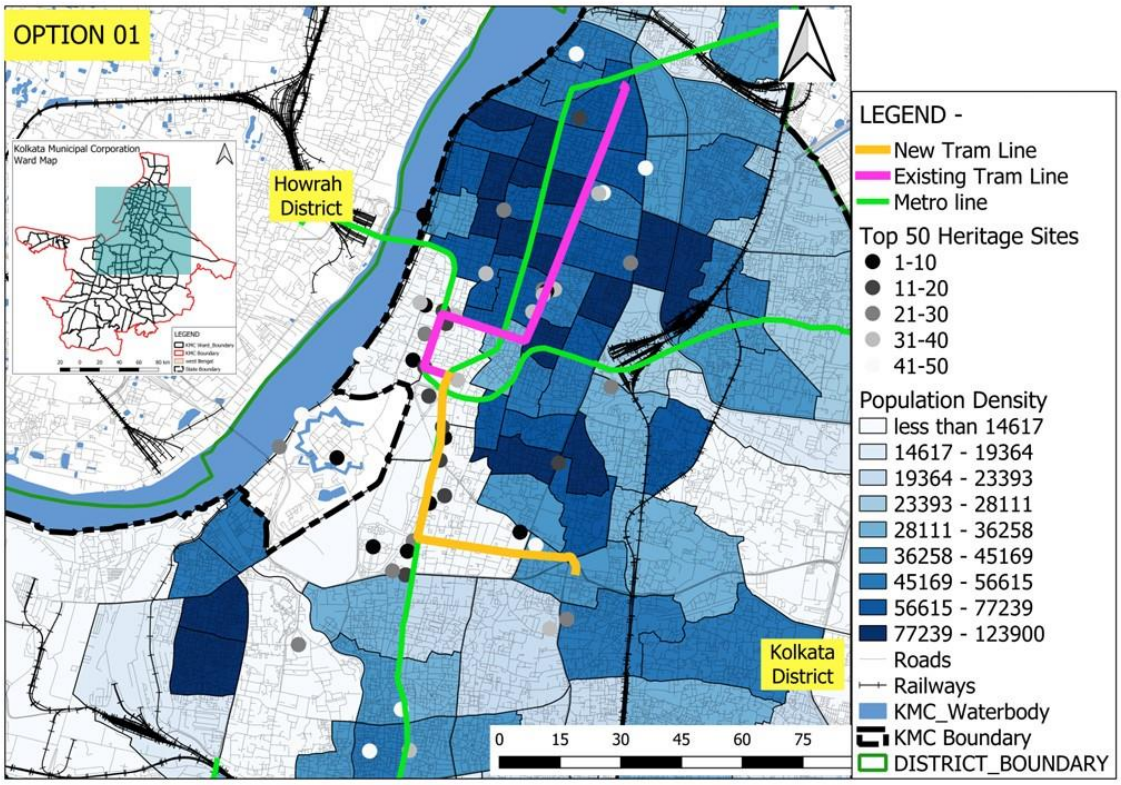
viii. Avoiding Flyover & Major Junction

5.7.1 Proposed Route: Option 01

This tram route proposes a dual-directional tram line within a single corridor. The right of way (ROW) dedicated to the tram system varies in width, ranging from 12 meters to 36 meters. This translates to a land use utilization of approximately 17% to 42% within the designated corridor. The route primarily traverses' areas classified as mixed-use, residential, and recreational, catering to a diverse range of users. With a total length of 10 kilometres, a noteworthy 33% of the route runs alongside an existing metro corridor, potentially offering seamless transfers and integrated public transport connectivity. Interestingly, the plan leverages 5.6 kilometres of existing tram lines, minimizing the need for entirely new construction. This results in the construction of just 4.4 kilometres of fresh tram infrastructure. Notably, the route minimizes its impact on heritage sites, with only 23 such locations falling within a 500-meter proximity. Additionally, the design smartly avoids the need to navigate 2 flyovers and major junctions, potentially reducing construction complexities and delays. This thoughtful planning demonstrates a focus on utilizing existing infrastructure, minimizing environmental impact, and ensuring a smooth and efficient tram operation (Map 12 and 13).



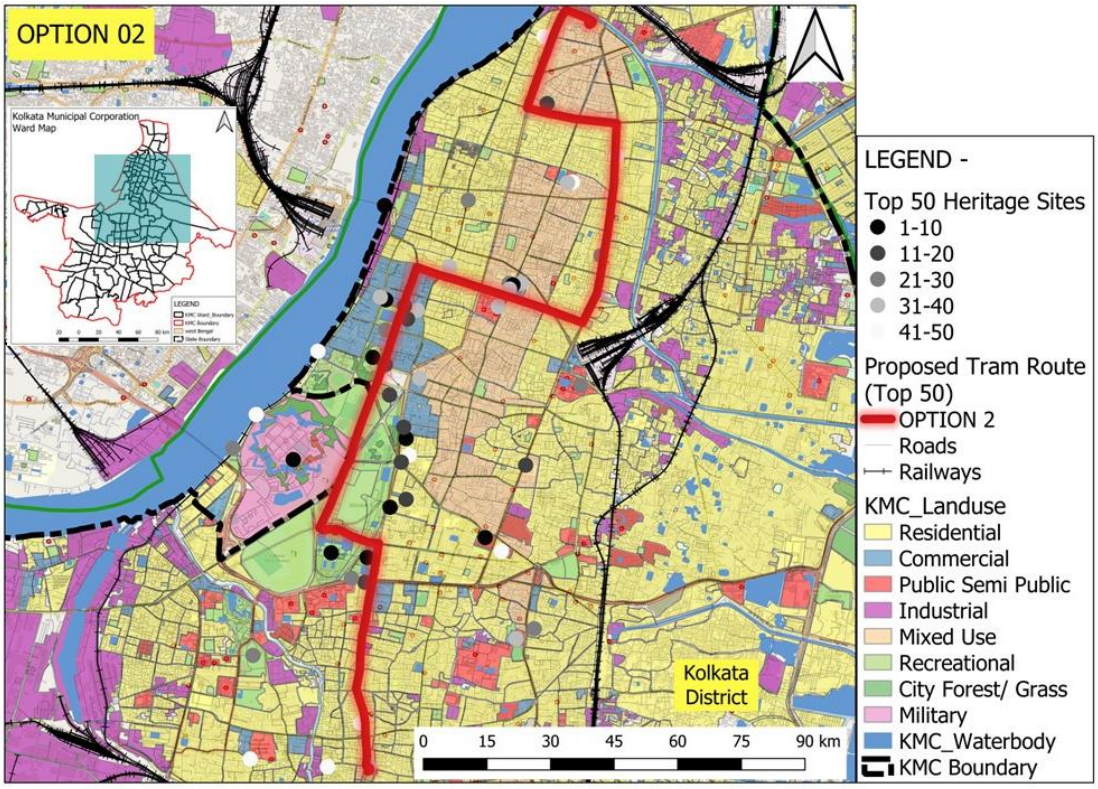
Map 12: Option 01: Proposed Route Along with Landuse
Source: Author Generated



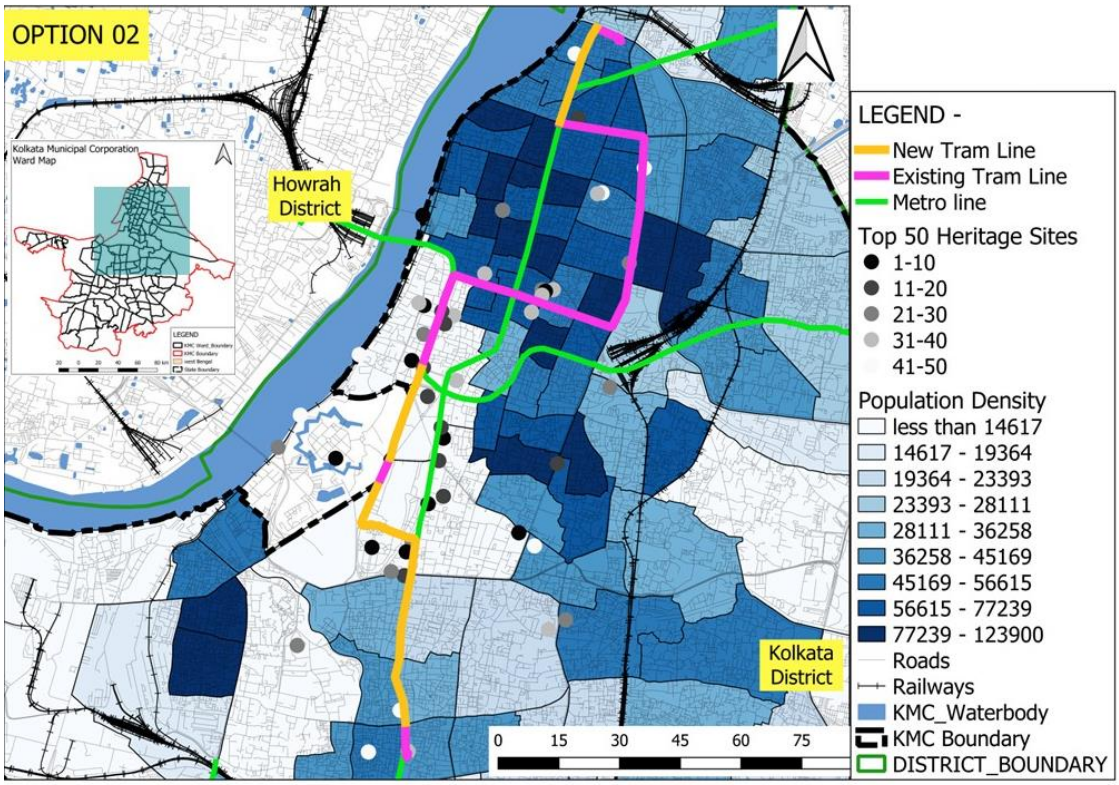
Map 13: Option 01: Proposed Route Along with Population Density Map
Source: Author Generated

5.7.2 Proposed Route: Option 02

This tram route proposes a dual-directional tram line within a single corridor. The right of way (ROW) dedicated to the tram system varies in width, ranging from 15 meters to 32 meters. This translates to a land use utilization of approximately 14% to 33% within the designated corridor. The route primarily traverses areas classified as residential, Commercial and recreational, catering to a diverse range of users. With a total length of 14.8 kilometers, a noteworthy 32% of the route runs alongside an existing metro corridor, potentially offering seamless transfers and integrated public transport connectivity. Interestingly, the plan leverages 8.2 kilometers of existing tram lines, minimizing the need for entirely new construction. This results in the construction of just 6.6 kilometers of fresh tram infrastructure. Notably, the route minimizes its impact on heritage sites, with only 22 such locations falling within a 500-meter proximity. Additionally, the design smartly avoids the need to navigate 5 flyovers and major junctions, potentially reducing construction complexities and delays. This thoughtful planning demonstrates a focus on utilizing existing infrastructure, minimizing environmental impact, and ensuring a smooth and efficient tram operation (Map 14 and 15).



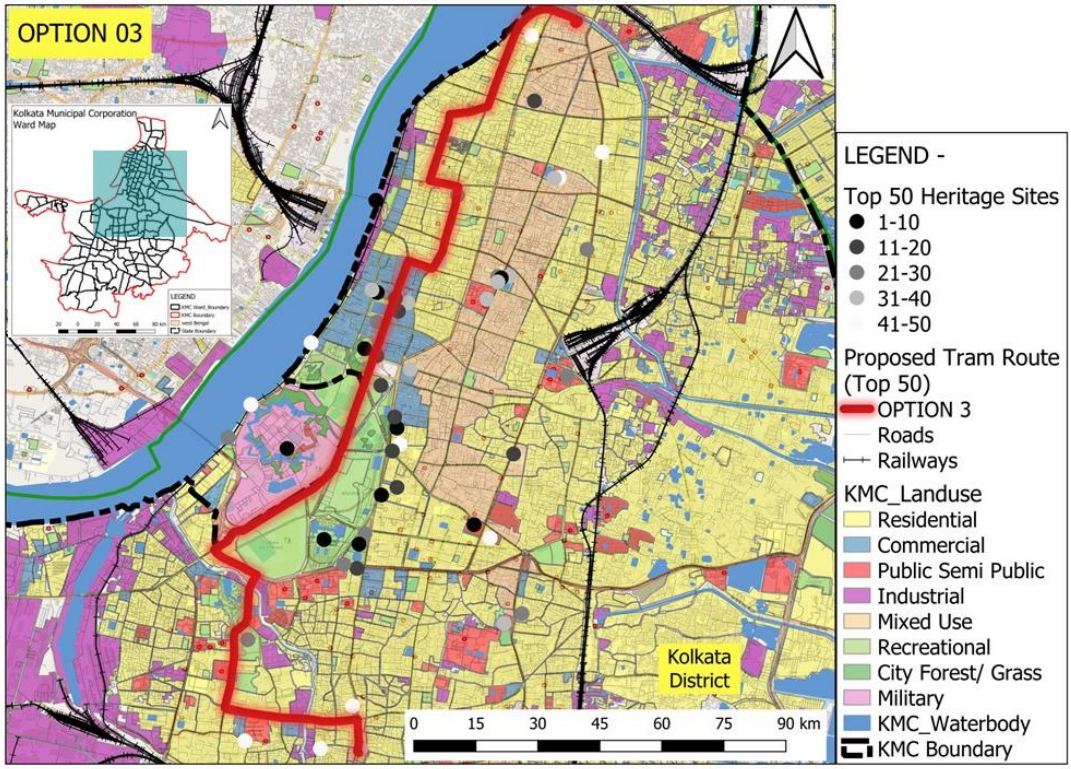
Map 14: Option 02: Proposed Route Along with Landuse
Source: Author Generated



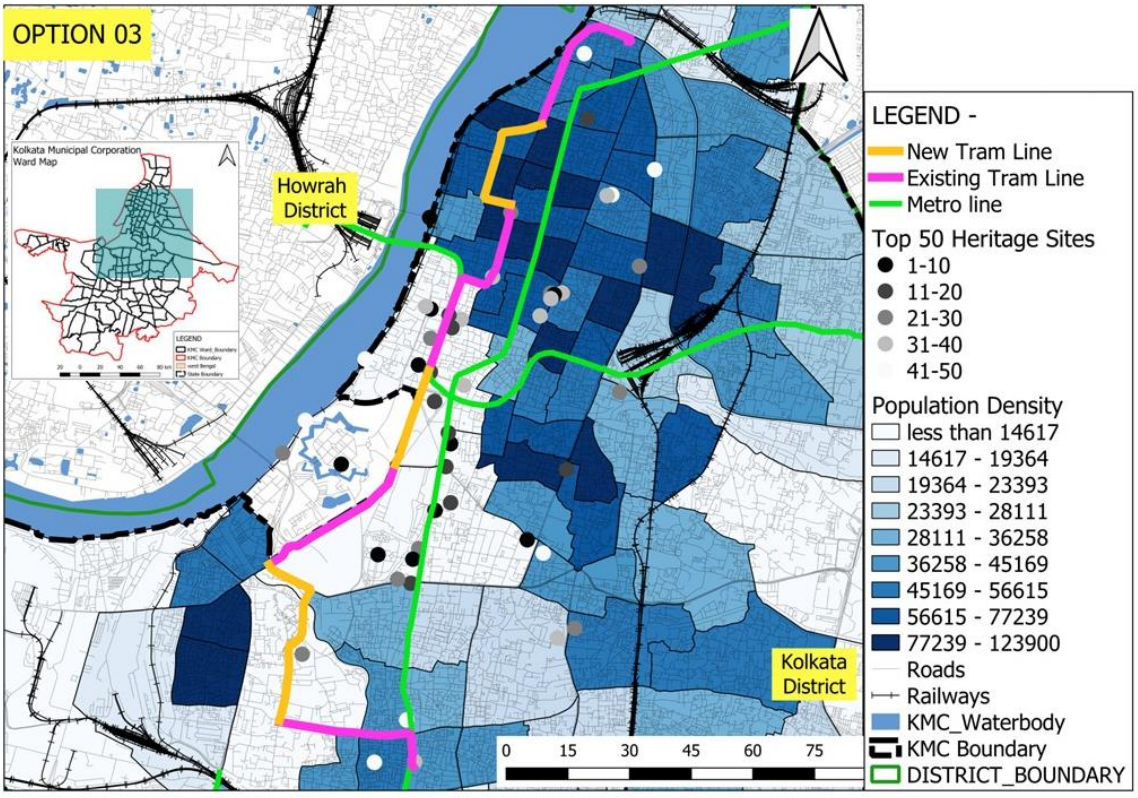
Map 15: Option 02: Proposed Route Along with Population Density Map
Source: Author Generated

5.7.3 Proposed Route: Option 03

This tram route proposes a dual-directional tram line within a single corridor. The right of way (ROW) dedicated to the tram system varies in width, ranging from 14 meters to 45 meters. This translates to a land use utilization of approximately 11% to 29% within the designated corridor. The route primarily traverses areas classified as residential, Commercial and recreational, catering to a diverse range of users. With a total length of 14.4 kilometers, a noteworthy 13% of the route runs alongside an existing metro corridor, potentially offering seamless transfers and integrated public transport connectivity. Interestingly, the plan leverages 8.9 kilometers of existing tram lines, minimizing the need for entirely new construction. This results in the construction of just 5.5 kilometers of fresh tram infrastructure. Notably, the route minimizes its impact on heritage sites, with only 13 such locations falling within a 500-meter proximity. Additionally, the design smartly avoids the need to navigate 3 flyovers and major junctions, potentially reducing construction complexities and delays. This thoughtful planning demonstrates a focus on utilizing existing infrastructure, minimizing environmental impact, and ensuring a smooth and efficient tram operation (Map 16 and 17).



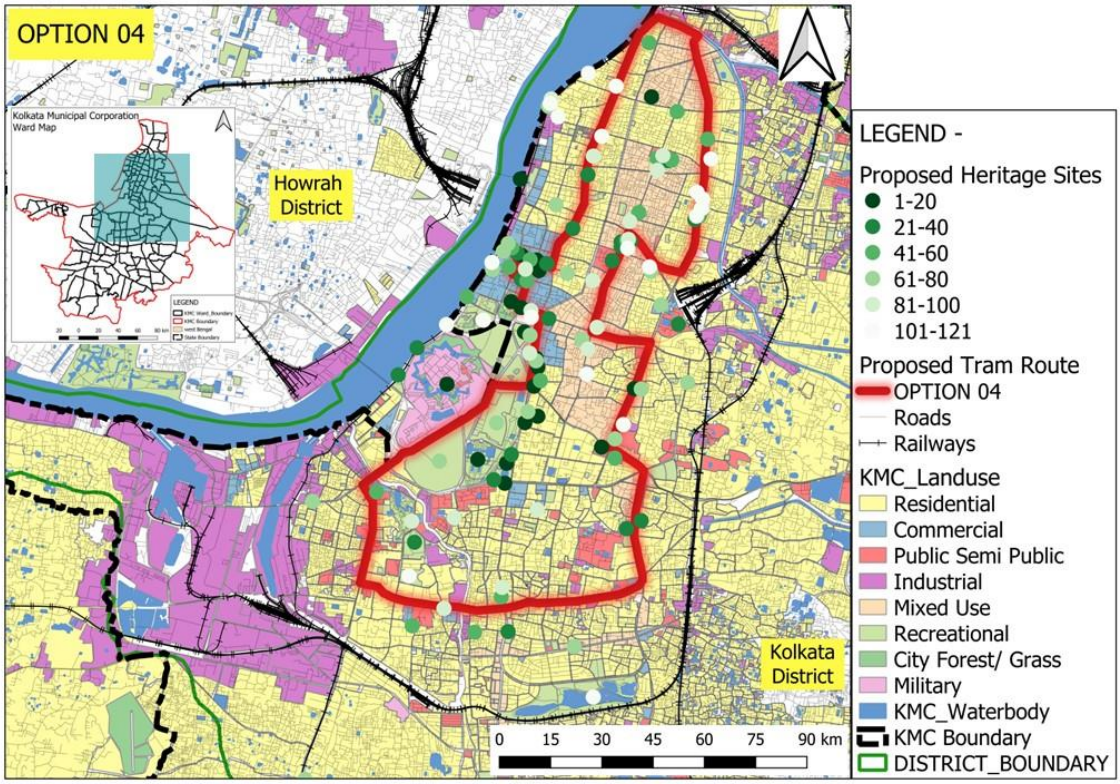
Map 16: Option 03: Proposed Route Along with Landuse
Source: Author Generated



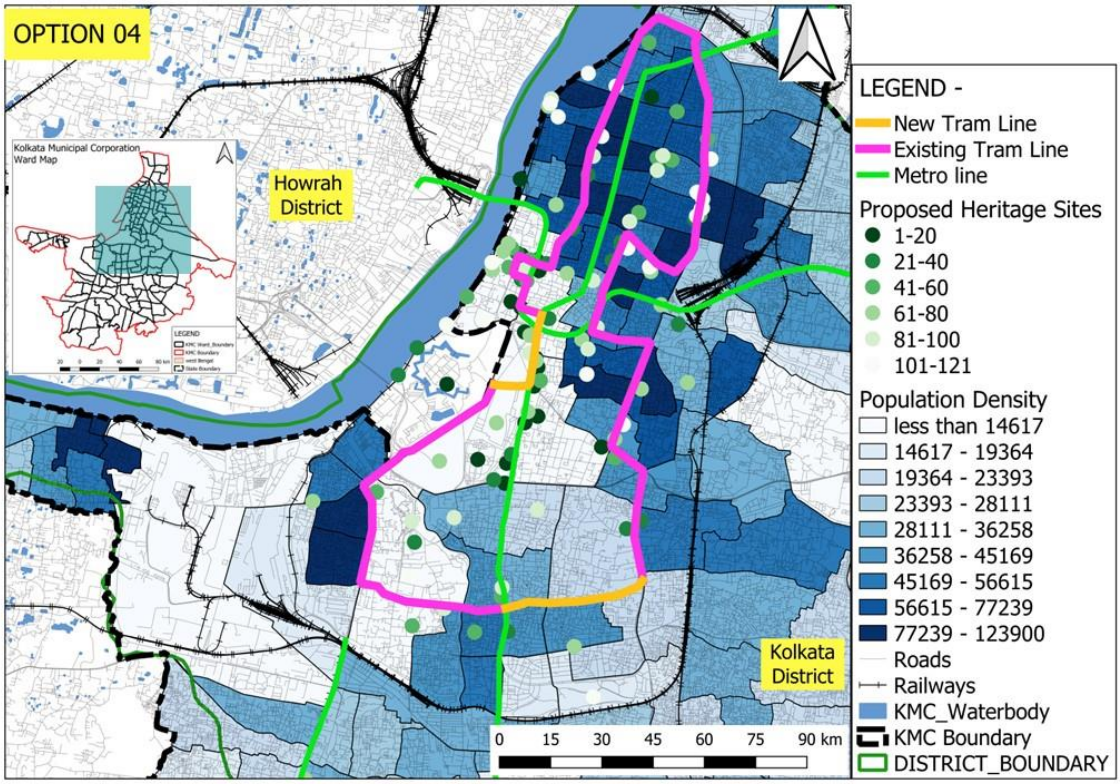
Map 17: Option 03: Proposed Route Along with Population Density Map
Source: Author Generated

5.7.4 Proposed Route: Option 04

This tram route proposes a single directional tram line within a single corridor. The right of way (ROW) dedicated to the tram system varies in width, ranging from 16 meters to 45 meters. This translates to a land use utilization of approximately 4% to 12.50% within the designated corridor. The route primarily covers all land use zones, catering to a diverse range of users. With a total length of 28.5 kilometers, a noteworthy 6.6% of the route runs alongside an existing metro corridor, potentially offering seamless transfers and integrated public transport connectivity. Interestingly, the plan leverages 24.9 kilometers of existing tram lines, minimizing the need for entirely new construction. This results in the construction of just 3.6 kilometers of fresh tram infrastructure. Notably, the route minimizes its impact on heritage sites, with only 79 such locations falling within a 500-meter proximity. Additionally, the design smartly avoids the need to navigate 5 flyovers and major junctions, potentially reducing construction complexities and delays. This thoughtful planning demonstrates a focus on utilizing existing infrastructure, minimizing environmental impact, and ensuring a smooth and efficient tram operation (Map 18 and 19).



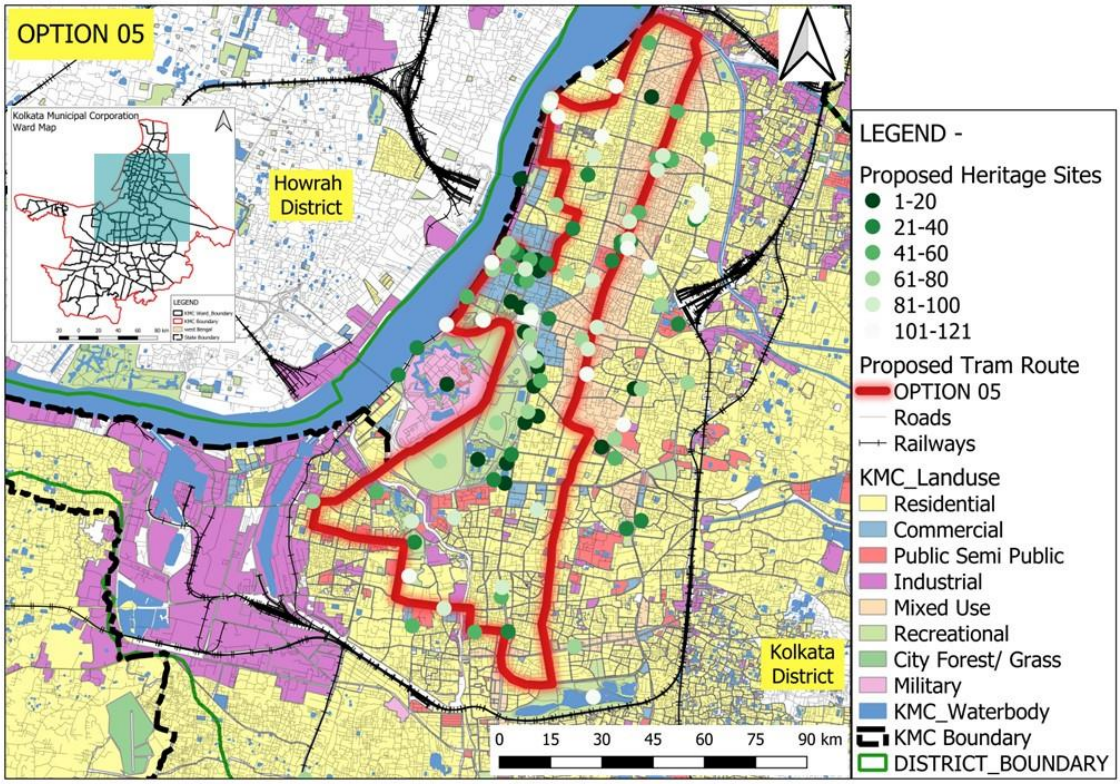
Map 18: Option 04: Proposed Route Along with Landuse
Source: Author Generated



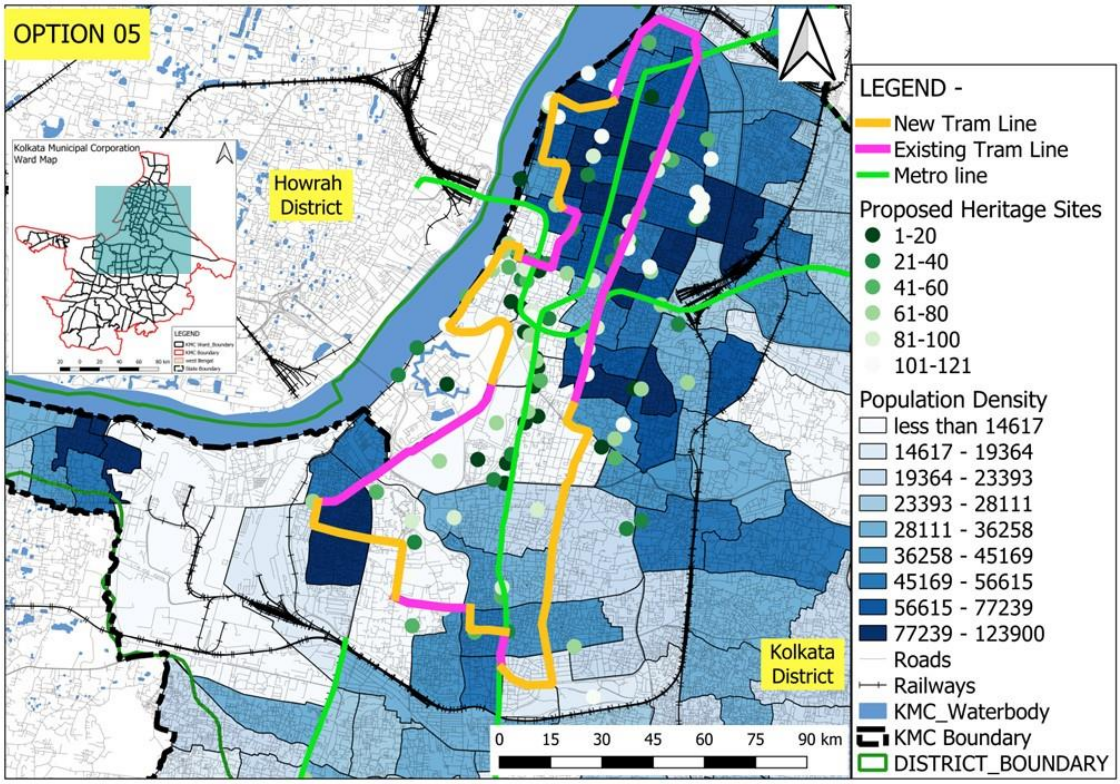
Map 19: Option 04: Proposed Route Along with Population Density Map
Source: Author Generated

5.7.5 Proposed Route: Option 05

This tram route proposes a single directional tram line within a single corridor. The right of way (ROW) dedicated to the tram system varies in width, ranging from 14 meters to 45 meters. This translates to a land use utilization of approximately 4% to 14% within the designated corridor. The route primarily covers Residential and Mixed-use zones, catering to a diverse range of users. With a total length of 31 kilometers, a noteworthy 3.5% of the route runs alongside an existing metro corridor, potentially offering seamless transfers and integrated public transport connectivity. Interestingly, the plan leverages 13.6 kilometers of existing tram lines, minimizing the need for entirely new construction. This results in the construction of just 17.4 kilometers of fresh tram infrastructure. Notably, the route minimizes its impact on heritage sites, with only 58 such locations falling within a 500-meter proximity. Additionally, the design smartly avoids the need to navigate 1 flyovers and major junctions, potentially reducing construction complexities and delays. This thoughtful planning demonstrates a focus on utilizing existing infrastructure, minimizing environmental impact, and ensuring a smooth and efficient tram operation (Map 20 and 21).



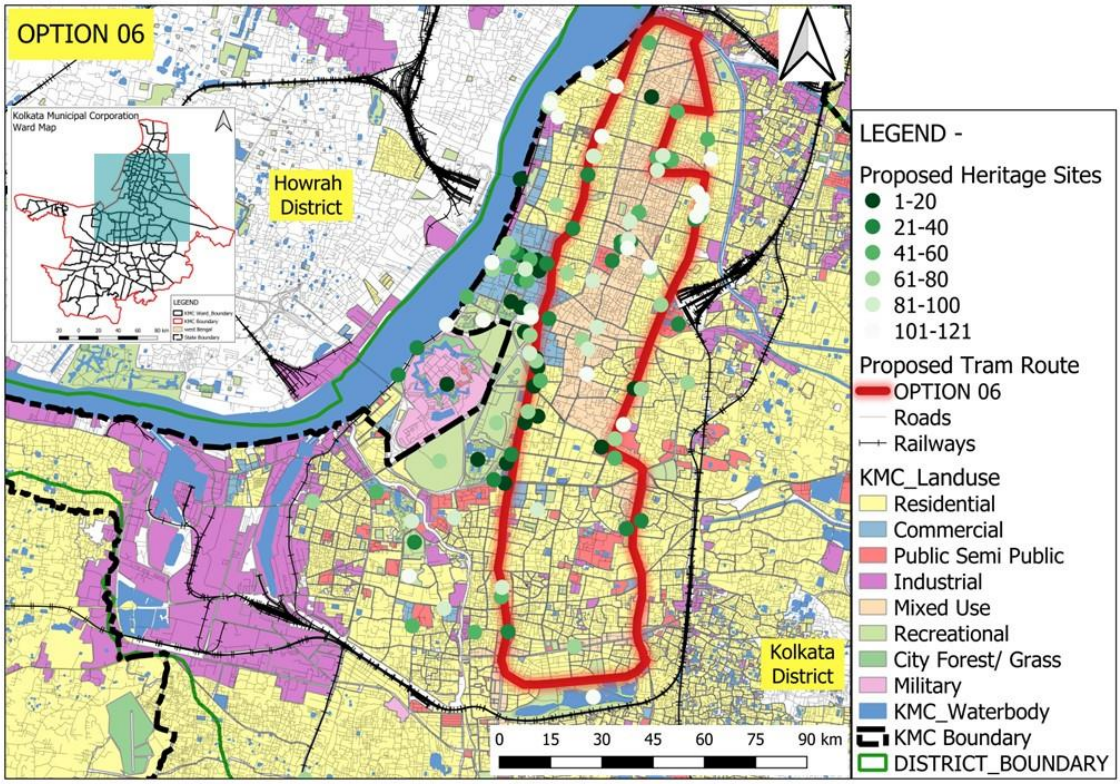
Map 20: Option 05: Proposed Route Along with Landuse
Source: Author Generated



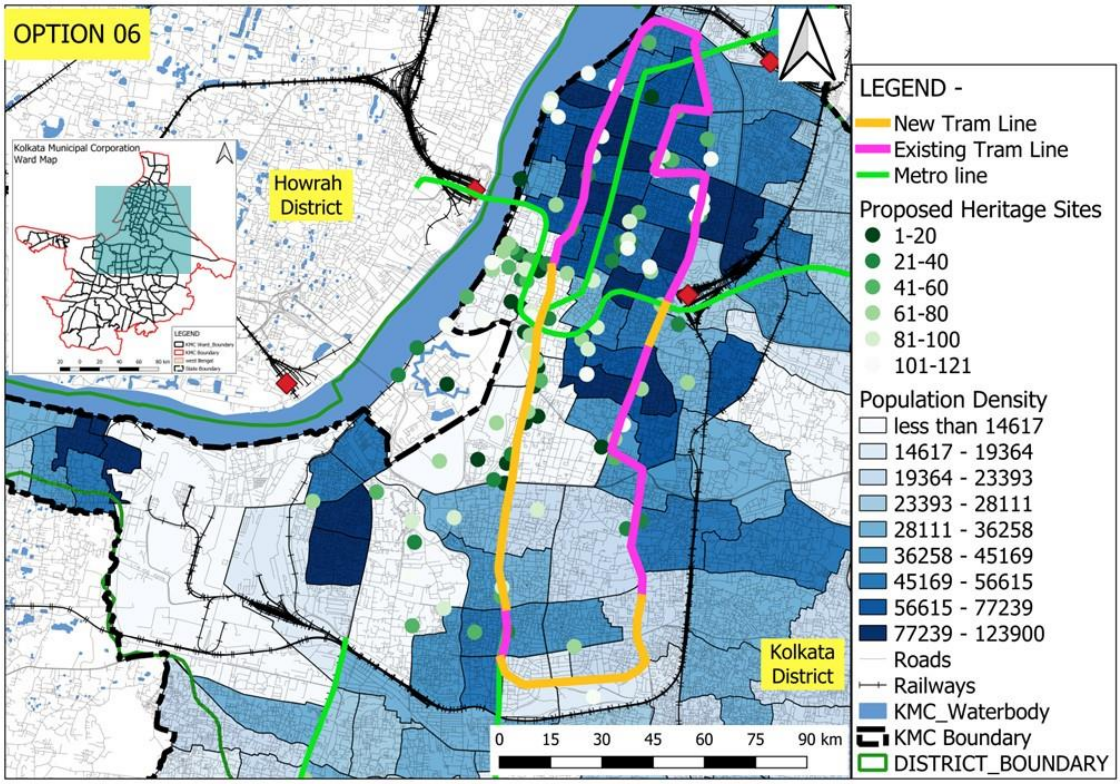
Map 21: Option 05: Proposed Route Along with Population Density Map
Source: Author Generated

5.7.6 Proposed Route: Option 06

This tram route proposes a single directional tram line within a single corridor. The right of way (ROW) dedicated to the tram system varies in width, ranging from 17 meters to 36 meters. This translates to a land use utilization of approximately 6% to 12% within the designated corridor. The route primarily covers Residential, PSP and Recreational zones, catering to a diverse range of users. With a total length of 25.5 kilometers, a noteworthy 22% of the route runs alongside an existing metro corridor, potentially offering seamless transfers and integrated public transport connectivity. Interestingly, the plan leverages 15.8 kilometers of existing tram lines, minimizing the need for entirely new construction. This results in the construction of just 9.7 kilometers of fresh tram infrastructure. Notably, the route minimizes its impact on heritage sites, with only 58 such locations falling within a 500-meter proximity. Additionally, the design smartly avoids the need to navigate 1 flyovers and major junctions, potentially reducing construction complexities and delays. This thoughtful planning demonstrates a focus on utilizing existing infrastructure, minimizing environmental impact, and ensuring a smooth and efficient tram operation (Map 22 and 23).



Map 22: Option 06: Proposed Route Along with Landuse
Source: Author Generated



Map 23: Option 06: Proposed Route Along with Population Density Map
Source: Author Generated

5.8 Comparison of Heritage Routes

A comprehensive evaluation of all six heritage route options based on the established parameters has revealed Option 4 as the most favourable choice (Table 8). This conclusion stems from its superior performance across various critical aspects. It demonstrates exceptional potential for successful implementation within the KMC area.

Option 4 stands out due to several key strengths. It prioritizes the utilization of existing tram infrastructure, minimizing the need for extensive new construction. This not only translates to cost savings but also reduces potential disruptions during the implementation phase. Furthermore, the route boasts a significant 6.6% overlap with an existing metro corridor, paving the way for seamless integration between different public transportation modes, thereby enhancing overall connectivity.

Moreover, Option 4 demonstrates a commendable sensitivity towards heritage preservation. The minimal impact on heritage sites, with 79 locations falling within a 500-meter proximity, signifies a well-considered approach that prioritizes cultural conservation. Additionally, the route cleverly avoids navigating major junctions and flyovers, potentially streamlining the construction process, and mitigating potential delays.

Therefore, based on a holistic assessment of the various route options, Option 4 emerges as the most compelling choice for implementation within the KMC area. Its strategic utilization of existing infrastructure, focus on public transport integration, and respect for heritage preservation make it a well-rounded and sustainable solution for the city's public transportation needs.

Table 8: Comparison Table of Heritage Routes

Comparison Table of Heritage Routes								
Sl. No.	Parameters		Tram line in Both Direction			Tram line One Direction Only		
			Option 01	Option 02	Option 03	Option 04	Option 05	Option 06
1	Suitable ROW (Range) (In Mts.)		(12-36)	(15-32)	(14-45)	(16-45)	(14-45)	(17-36)
2	% of ROW Use		(17-42)%	(14-33)%	(11-29)%	(4-12.5)%	(4-14)%	(6 - 12)%
3	Major Land Use Covered	Residential						
		Commrercial						
		PSP						
		Industrial						
		Mixed Use						
		Recreational						
		City Forest						
		Military						
4	Route Length (Km)		10	14.8	14.4	28.5	31	25.5
5	% of route along Metro Corridor		33%	32%	13%	6.60%	3.50%	22%
6	Existing & New Tram Lines	Existing Tram Line (Km)	5.6	8.2	8.9	24.9	13.6	15.8
		New Tram Lines (Km)	4.4	6.6	5.5	3.6	17.4	9.7
7	Heritage Site Coverage (Close Proximity) (500mts. Walking Distance)		23	22	13	79	58	57
8	Avoiding Flyover & Major Junction	Flyover	0	2	1	3	1	0
		Major Junction	2	3	2	2	0	1

Most Preferable Average Least Preferable

Source: Author Generated

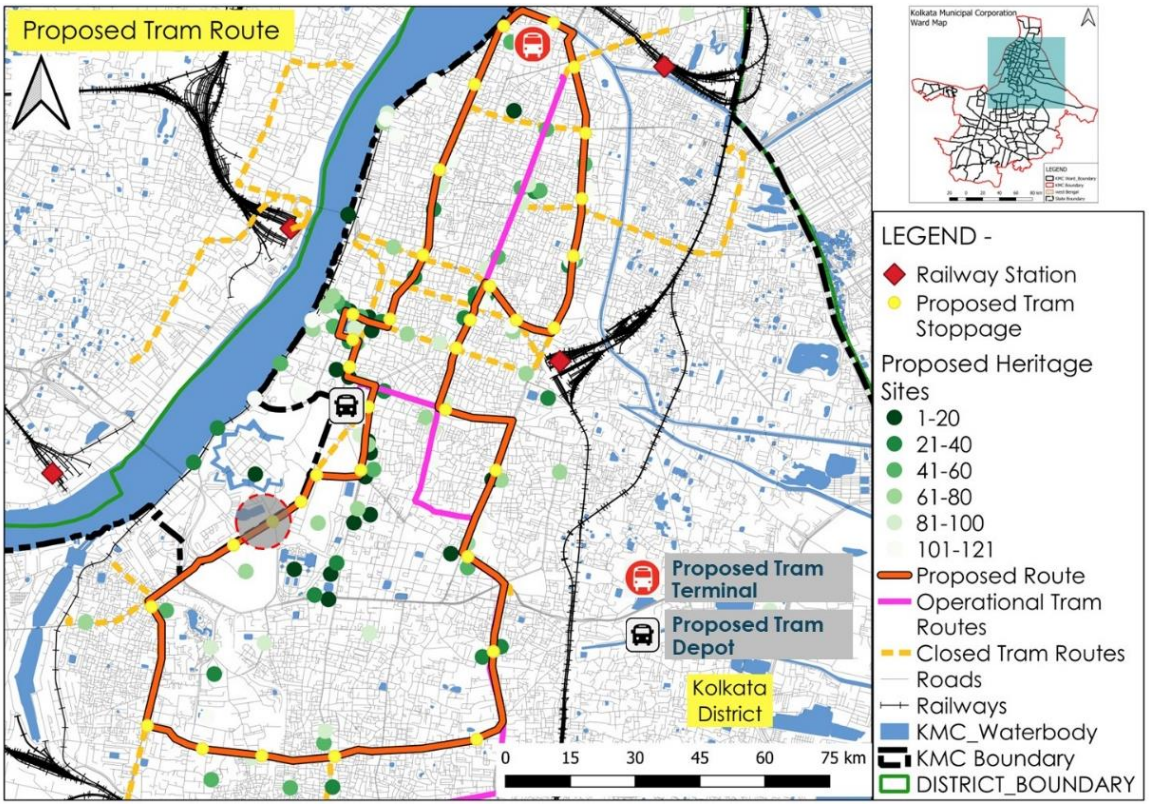
CHAPTER 6: PROPOSALS AND RECOMMENDATIONS

6.1 Proposed Tram Route

Kolkata's trams hold immense potential to act as a catalyst for tourism development in the city for several compelling reasons:

i. **Scenic Routes:** Tram routes often traverse the heart of Kolkata, taking passengers on picturesque journeys that showcase the city's landmarks, historical sites, and bustling neighbourhoods. These routes can be strategically designed to cover popular tourist attractions like Victoria Memorial, Howrah Bridge, Indian Museum, and College Street, providing tourists with a visual feast of the city's sights and sounds. The leisurely pace allows for a more immersive experience, enabling tourists to truly appreciate the city's unique atmosphere.

ii. **Infrastructure and Development:** Investing in tram infrastructure and related facilities can significantly boost tourism development in Kolkata. Improved tram networks, modernized tram stations, and informative signboards can enhance the overall experience for tourists. Additionally, developing thematic tram tours, such as cultural or historical routes, can cater to specific tourist interests and create unforgettable memories. By embracing trams as a tourism asset, Kolkata can unlock its potential as a captivating and culturally rich destination.



Map 24: Proposed Tram Route
Source: Author Generated

An interesting aspect of these tram route options is the significant variation in road width along the proposed corridors. This range, spanning from 17 meters to 48 meters, (Figure 28) presents both opportunities and challenges for tram implementation. Wider roads, reaching up to 48 meters, offer ample space for the tram infrastructure, potentially allowing for dedicated tram lanes and segregated boarding areas. This could significantly enhance passenger safety and operational efficiency.

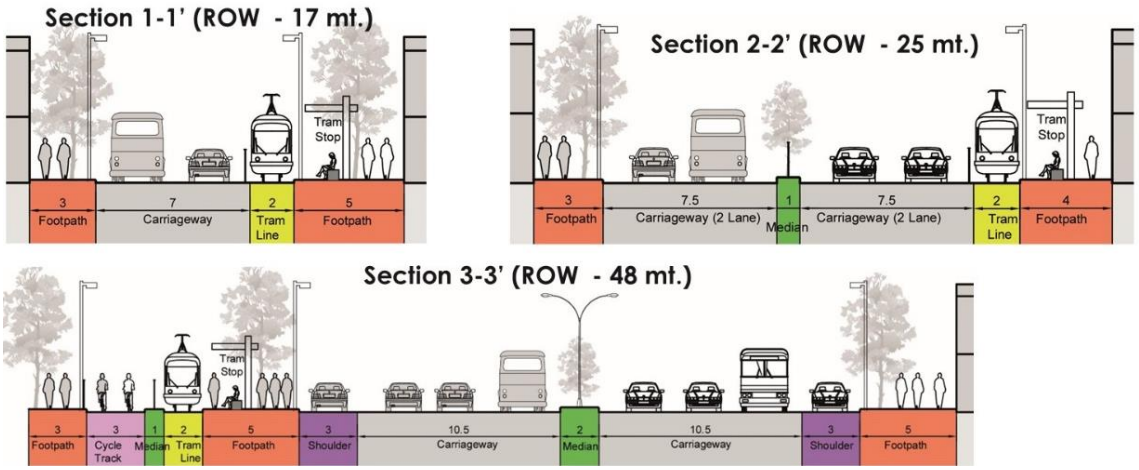


Figure 28: Proposed Cross Section with Tram Route
Source: Author Generated

Figure 29: Proposed Tram Stoppage
Source: Author Generated

The proposed tram route boasts a substantial length of 28.5 kilometers, dotted with 35 conveniently located tram stops. To ensure smooth operations and passenger convenience, a calculated layover time of 10 minutes has been allocated at each terminal station. This allows for passenger boarding, disembarking, and operational checks before trams commence their journeys

Considering a tram speed of 20 kilometers per hour, the total journey time along the route is estimated to be 100 minutes. This includes designated halting time of

15 minutes, spread across the 35 stops, which provides passengers with ample opportunity to board, disembark, and switch routes if necessary. The remaining 85 minutes constitute the running time, during which the tram travels uninterrupted between stops (Table 9).

Furthermore, a calculated headway of 15 minutes has been proposed. This signifies that a new tram will be introduced onto the route every 15 minutes, ensuring a consistent frequency of service, and minimizing passenger waiting times.

Table 9: Configuration of Proposed Tram Route

Proposed Tram Route							
Length (KM)	Tram Stops	Layover Time (Min.)	Total Halt Time (MIn.)	Running Time (Min.)	Journey Time (Min.)	Min. Calculated Headway (Min.)	Proposed Headway (Min.)
28.5	**35**	**10**	**15**	**85**	**100**	**10**	**15**

Source: Author Generated

6.2 Modified Tram Depot

Kolkata's tram network relies heavily on efficient tram depots for smooth operations. Among these, the Esplanade Depot holds immense significance due to its strategic location at the heart of the city. It serves as the starting point for over seven tram routes, making it a vital hub for tram operations. However, the current state of the depot, marred by improper management, necessitates urgent revitalization efforts.

Redeveloping the Esplanade Depot presents a golden opportunity to not only provide essential shedding and boarding facilities for the modern LRVs (Light Rail Vehicles) but also establish a new passenger station for enhanced commuter convenience. Furthermore, the site's existing role as an exit point for the Esplanade metro station (Gate no. 4) and a WBTC bus stand offers a unique chance to create a multi-modal transit hub. This integration would significantly improve ridership by providing seamless connectivity between trams, buses, and the metro network.

(Figure 30) depict the current scenario of the Esplanade Depot, highlighting the underutilized and disorganized nature of the space. This underutilization presents a compelling opportunity to develop a transit hub within the heart of the city. By integrating bus and metro services with the modernized tram network, the

revitalized Esplanade Depot can attract passengers from urban peripheries who utilize buses for their initial journey into the city centre. This strategic integration has the potential to significantly boost tram ridership, transforming the depot into a vibrant hub for public transportation within Kolkata.

Figure 30: Existing Tram Depot Scenario
Source: Author Generated

The proposed Tram Depot as multi-modal hub at the Esplanade Depot transcends the limitations of a traditional tram depot, (Figure 31) transforming it into a vibrant centre for seamless connectivity. This strategic plan envisions a space that not only caters to trams but also integrates bus and metro services, creating a unified transportation hub. By physically connecting these vital modes of transport, the hub aims to significantly enhance the passenger experience, making transfers between buses, trams, and the metro network effortless and convenient.

Figure 31: Proposed Depot at Esplanade Depot
Source: Author Generated

6.2.1 Proposed View of Modified Tram Depot

The revitalization plan for the Esplanade tram depot proposes a strategic location for the tram facilities within the site. The depot itself is situated on the eastern edge of the property, along the bustling Chowringhee Road. This placement ensures convenient access for trams entering and exiting the depot, minimizing disruption to other transportation modes (Figure 32). Additionally, a direct connection is established between the tram depot and the Esplanade metro station exit on the southern side of the site. This seamless integration between the tram and metro networks fosters effortless passenger transfers and eliminates the need for lengthy walks or circuitous routes. By carefully considering the location of the tram depot and its connection to the metro, the plan prioritizes passenger convenience and operational efficiency, creating a user-friendly multi-modal hub within the heart of Kolkata.

Figure 32: Proposed View of Tram Depot
Source: Author Generated

6.2.2 Proposed Parking Area of Modified Tram Depot

Recognizing the needs of individuals who might travel to the Esplanade depot from various parts of the city, the redevelopment plan incorporates a dedicated parking area within the premises. This designated parking space offers convenience to passengers who intend to utilize the tram network for their onward journeys. By providing a secure and organized parking facility, (Figure 33) the plan aims to encourage individuals to choose tram travel over private vehicles, potentially reducing traffic congestion within the city centre.

Figure 33: Proposed Parking Area
Source: Author Generated

6.3 Recommendations

6.3.1 Financial Aspects

i. **Government Funds:** Government Funds are primary financial resources. These grants can help both from state and national level.

a. The revitalization of the Esplanade tram depot presents a compelling opportunity to leverage the financial support offered by the central government of India through various urban development schemes. Initiatives like the Smart Cities Mission, Atal Mission for Rejuvenation and Urban Transformation (AMRUT), and its successor AMRUT 2.0 are designed to provide critical grants for infrastructure projects that improve urban mobility and sustainability.

b. The state government of West Bengal can allocate funds from its annual budget for urban transport infrastructure projects. They may specifically earmark funds for the redevelopment of trams in Kolkata as part of their transportation development plans.

c. The Kolkata Municipal Corporation (KMC) can allocate funds from its budget for the redevelopment of trams within its jurisdiction. The KMC's budget can

be utilized to support infrastructure improvements, track modernization, tram depot upgrades, and other related initiatives.

d. The central and state governments sometimes provide special purpose grants for specific infrastructure projects. Kolkata's tramway redevelopment can be considered for such grants if it aligns with the government's priorities and objectives.

ii. Global Funds: Several global resources are working to develop Transport infrastructure in different cities. Here are some examples:

a. The IFC, a member of the World Bank Group, supports infrastructure projects worldwide, including transportation. They provide advisory services, financing, and expertise in structuring and implementing PPPs for tram and LRT projects.

b. The EBRD is a multilateral development bank focused on supporting sustainable and inclusive development. They have experience in financing and advising on urban transport projects, including tram and LRT systems, in various countries.

c. The ADB is another multilateral development bank that supports infrastructure development, including urban transport projects. They offer financial assistance, technical expertise, and guidance on implementing PPP models for tram and LRT systems.

d. The UITP is a global organization dedicated to promoting sustainable mobility and public transport. They provide guidance, knowledge sharing, and best practices for implementing and operating tram and LRT systems, including PPP projects.

6.3.2 Planning Aspects

A comprehensive and effective planning is needed for the redevelopment of Tramways in Kolkata. Some of the important planning aspects are mentioned below.

Some popular LRV manufacturers include Bombardier Transportation, Alstom, Siemens, CAF, and Kinki Sharyo. These manufacturers have developed a range of LRV models that have been successfully deployed in different urban tramway systems. In Kolkata’s context, CAF Urbos models and Citadis X02 (Second

generation) models can be used. the base price for a single Citadis tram unit ranged from approximately €2 million to €4 million (17 – 33 crore Indian rupees), depending on the specific configuration and additional features.

6.3.3 Technical Aspects

Several Engineering techniques can be implemented for promoting Tramways in Kolkata. Some of them are discussed below.

i. One of the major challenges currently plaguing Kolkata's tram system is the issue of irregular schedules. This inconsistency often stems from a lack of public awareness regarding designated tram routes and parking regulations. In various stretches along the routes, illegally parked cars obstruct existing tram lanes, creating significant bottlenecks. This forces trams to make unscheduled stops outside designated stations, significantly impacting their overall speed and adherence to timetables. These unscheduled halts disrupt the smooth flow of tram traffic, leading to delays and frustration among passengers who rely on the trams for timely commutes.

ii. Route remapping emerges as a crucial aspect of developing tram routes in Kolkata. This strategic process involves reorganizing existing bus lines to complement and optimize the new tram network. By meticulously planning bus route adjustments, the goal is to create seamless integration between these vital modes of public transport. This integration fosters efficient passenger transfers, reduces the need for circuitous journeys, and optimizes the overall utilization of public transportation resources. Through route remapping, areas with high passenger density can be strategically served by both trams and buses, offering commuters a wider range of travel options, and reducing reliance on private vehicles. This collaborative approach has the potential to significantly improve public transportation efficiency, leading to reduced travel times, lower congestion levels, and a more sustainable urban environment for Kolkata.

6.4 Future Scope of the Study

The potential for tram revival extends beyond Kolkata's borders. The success of a revitalized tram network within the KMC area can pave the way for its reintroduction in neighbouring municipalities like the Howrah Municipal Corporation (HMC). A popular route, the Howrah Maidan – Ballygunge Circular Road traversing the iconic Howrah Bridge, presents a compelling opportunity for reconnection. This strategic expansion would not only re-establish the historical link between Howrah and Kolkata through trams but also create a vital connection between these densely populated urban centres.

Furthermore, the success of this initial expansion can serve as a springboard for introducing tram routes in neighbouring councils like New Town. By strategically connecting these outlying areas with the KMC tram network, trams can be positioned as a convenient and sustainable mode of transport for commuters residing in the urban fringes surrounding Kolkata. This progressive expansion has the potential to significantly enhance public transportation accessibility and connectivity across the entire metropolitan region, transforming trams into a truly ubiquitous and well-integrated mode of urban mobility.

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Annexure I - Ranking of Heritage Sites in Kolkata

Sl. No	Main Parameter	Historical Significance (P1)		Architectural Significance (P2)		Socio Economic Significance (P3)		Integrity (P4)		Proximity (P5)		WSM Score	Rank
	Sub Parameter	Age of the Structure (P11)	Association Involved (P12)	Aesthetic value (P21)	Style of Construction (P22)	Community Association (P31)	Tourism Potential (P32)	Condition of Structure (P41)	Functionality (P42)	Distance from existing tram line (P51)	Distance from existing tram Depot/Terminal (P52)		
	Weightage Value	0.165	0.165	0.135	0.135	0.1	0.1	0.065	0.065	0.035	0.035		
1	Victoria Memorial	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95875	**1**
2	Fort William	1.00	1.00	0.75	0.75	1.00	1.00	1.00	0.75	0.50	0.50	0.88125	**9**
3	Howrah Bridge	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.50	0.91625	**4**
4	Princep Ghat	1.00	0.50	0.50	0.75	1.00	1.00	0.75	1.00	0.75	0.75	0.78250	**24**
5	Birla Planetorium	0.50	0.50	1.00	1.00	1.00	1.00	0.25	1.00	0.75	0.75	0.76875	**26**
6	St. Paul Cathedral	1.00	1.00	0.75	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.94875	**2**
7	Shahid Minar	1.00	0.75	0.50	0.75	1.00	0.75	1.00	1.00	1.00	1.00	0.83250	**15**
8	Raj Bhawan	1.00	1.00	1.00	1.00	1.00	0.75	1.00	0.75	0.75	0.75	0.94125	**3**
9	Sovabazar Rajbari	1.00	0.50	0.75	0.75	1.00	1.00	1.00	0.50	0.75	0.50	0.79125	**20**
10	Writers Building	1.00	0.75	1.00	1.00	1.00	0.75	0.75	0.75	1.00	0.75	0.89250	**6**
11	Dhurjoti Bhawan	0.50	0.25	0.50	0.50	0.50	0.50	0.50	0.25	1.00	1.00	0.47750	**96**
12	Gouriya Math	0.75	0.25	0.50	0.50	1.00	0.75	0.75	0.25	0.75	0.75	0.59250	**69**
13	Rameswar Siva Temple	0.50	0.25	0.25	0.00	0.25	0.25	0.75	0.00	0.50	0.50	0.29125	**120**
14	Putul Bari	0.50	0.25	0.50	0.50	0.25	0.25	0.00	0.25	0.50	0.50	0.36000	**111**
15	Star Theatre	1.00	0.25	0.50	0.75	0.75	1.00	0.25	0.25	1.00	1.00	0.65250	**58**
16	Bangiya Sahitya Parishad	1.00	0.50	0.50	0.50	1.00	1.00	0.50	0.75	0.75	0.50	0.70750	**42**
17	Scottish Church Collegiate School	1.00	0.50	0.50	0.50	0.75	1.00	0.75	0.50	1.00	0.75	0.70000	**43**
18	Ahiritola Ghat	1.00	0.50	0.25	0.00	0.25	0.75	0.50	0.50	0.75	0.50	0.49000	**95**
19	Manik Bose's Ghat	0.75	0.25	0.25	0.00	0.25	0.50	0.25	0.00	0.50	0.50	0.32500	**117**
20	Nimtala Burning Ghat	1.00	0.50	0.25	0.50	0.75	1.00	0.50	0.00	0.50	0.50	0.59125	**72**
21	Durgeswar Siva Temple	1.00	0.25	0.00	0.50	0.25	1.00	0.25	0.00	0.50	0.25	0.44125	**103**
22	Lohia Matri Seva Sadan	1.00	0.25	0.50	0.50	0.75	0.00	0.25	0.50	0.50	0.25	0.49125	**94**
23	Jorasanko Thakurbari	1.00	0.75	0.50	0.75	1.00	0.50	1.00	1.00	1.00	0.50	0.79000	**21**
24	Rabindra Kanan	0.75	0.25	0.00	0.00	0.75	1.00	0.25	0.00	0.50	0.50	0.39125	**107**
25	Christ Church	1.00	0.25	0.50	0.50	0.75	1.00	0.50	0.50	1.00	0.75	0.64250	**60**
26	Azad Hind Bag	0.75	0.25	0.00	0.25	0.75	1.00	0.25	0.00	1.00	1.00	0.46000	**100**
27	Scottish Church College	1.00	0.75	0.50	0.50	0.75	1.00	0.75	0.50	1.00	1.00	0.75000	**32**
28	Y.M.C.A - Vivekananda Road	1.00	0.25	0.25	0.25	0.75	0.75	0.25	0.00	1.00	0.75	0.50125	**92**
29	Police Museum	0.25	0.25	0.50	0.50	1.00	0.25	0.00	0.75	0.75	0.50	0.43500	**105**
30	Calcutta Deaf & Damb School	0.25	0.00	0.25	0.00	0.50	0.50	0.25	0.00	0.75	0.75	0.24375	**121**

31	Athenaeum Institution	1.00	0.25	0.25	0.25	0.50	0.75	0.25	0.00	0.75	1.00	0.47625	**97**
32	Brahmo Balika Sikshalaya	1.00	0.50	0.50	0.25	0.75	1.00	0.50	0.50	1.00	1.00	0.65875	**53**
33	Rammohan Library	0.50	0.00	0.25	0.00	0.50	1.00	0.00	0.25	1.00	0.75	0.34375	**114**
34	Church Mission Society Cemetry	0.75	0.25	0.00	0.25	0.50	0.00	0.25	0.50	1.00	0.50	0.35000	**113**
35	Calcutta University, Science College	0.50	0.75	0.75	0.75	1.00	1.00	0.75	0.50	1.00	1.00	0.76000	**28**
36	Jagadish Chandra Bose - House	0.75	0.00	0.50	0.25	0.50	0.00	0.00	0.50	1.00	1.00	0.37750	**108**
37	Thanthania Rajbati	1.00	0.75	0.75	0.50	0.75	0.25	0.25	0.50	1.00	0.50	0.65875	**54**
38	College Street Market	1.00	0.75	0.00	0.00	0.00	1.00	0.75	0.75	1.00	0.50	0.53875	**86**
39	College Square	1.00	0.50	0.00	0.00	0.00	1.00	0.50	0.25	1.00	0.50	0.44875	**102**
40	Hindu School	1.00	0.75	0.25	0.25	1.00	1.00	0.50	0.25	1.00	0.50	0.65750	**57**
41	Sanskrit College	1.00	0.75	0.50	0.50	1.00	1.00	0.25	0.50	1.00	0.50	0.72500	**36**
42	Indian Coffee House	0.50	0.50	0.25	0.25	0.75	1.00	0.50	0.75	1.00	0.50	0.54125	**85**
43	Bara Sikh Sangat	0.50	0.50	0.50	0.50	1.00	1.00	0.50	0.00	0.50	0.50	0.56750	**77**
44	Nakhoda Mosque	0.75	0.50	0.75	0.75	0.75	1.00	0.50	0.75	1.00	0.50	0.71750	**38**
45	Hare School	1.00	0.50	0.75	1.00	0.75	1.00	0.50	0.50	1.00	0.50	0.77625	**25**
46	Presidency College	1.00	0.75	1.00	1.00	1.00	1.00	0.50	0.75	1.00	0.50	0.89250	**7**
47	University of Calcutta	1.00	0.75	0.50	0.50	0.75	1.00	0.75	0.50	1.00	0.50	0.73250	**35**
48	Medical College	1.00	0.75	0.50	0.50	0.75	1.00	0.75	0.25	1.00	0.50	0.71625	**40**
49	Telephone Bhawan	0.50	0.75	0.50	0.50	1.00	1.00	0.25	0.50	1.00	1.00	0.66000	**51**
50	Eden Garden Park	0.50	0.00	0.00	0.00	1.00	1.00	0.25	0.00	0.75	0.75	0.35125	**112**
51	Colesworthy Grant Memorial	1.00	0.25	0.50	0.50	0.75	1.00	0.25	0.75	1.00	1.00	0.65125	**59**
52	Outram Ghat	1.00	0.50	0.00	0.00	0.25	0.50	0.25	0.00	0.50	0.50	0.37375	**109**
53	Babu Ghat	0.75	0.75	0.75	0.50	0.50	1.00	0.25	0.75	0.50	0.50	0.66625	**50**
54	Metcalfe Hall	1.00	0.50	0.75	0.50	0.75	0.25	0.25	1.00	0.50	0.50	0.63250	**61**
55	Former Reserve Bank Building	1.00	1.00	0.75	0.75	0.75	0.25	0.25	1.00	0.50	0.50	0.74875	**33**
56	Wallace House	1.00	0.50	0.75	0.75	0.50	0.25	0.25	1.00	0.75	0.75	0.65875	**54**
57	Customs House	0.75	0.75	0.25	0.50	1.00	1.00	0.50	0.25	0.25	0.00	0.60625	**66**
58	Central Telegraph Office	1.00	0.75	0.75	0.25	0.75	1.00	0.50	1.00	1.00	1.00	0.76625	**27**
59	Eastern Railway Office	0.75	0.75	0.50	0.50	0.50	1.00	0.50	0.50	0.75	1.00	0.65875	**54**
60	Police Headquarters	1.00	0.75	0.50	0.50	0.50	1.00	0.50	0.75	1.00	1.00	0.72500	**36**
61	Prince of Wales Visit Memorial	1.00	1.00	0.50	0.25	0.25	0.50	0.00	0.25	1.00	1.00	0.59250	**68**
62	St. Andrews Church	1.00	0.75	0.75	0.75	1.00	1.00	0.50	1.00	1.00	1.00	0.85875	**11**
63	Bidhan Sarovar or Lal Dighi	1.00	0.50	0.00	0.00	0.75	1.00	0.25	0.50	1.00	1.00	0.54125	**84**
64	Tower House	1.00	0.50	0.50	0.75	0.25	0.00	0.25	1.00	1.00	1.00	0.59250	**69**
65	Esplanade Mansion	1.00	1.00	1.00	0.75	0.75	0.50	0.50	1.00	0.75	1.00	0.85000	**12**
66	Carey Baptist Church	1.00	0.50	0.25	0.25	0.50	1.00	0.25	0.25	1.00	1.00	0.56750	**75**
67	Church of The Sacred Heart of Jesus	1.00	0.75	0.75	0.50	0.75	1.00	0.25	0.50	1.00	1.00	0.75125	**31**
68	Ordnance Factory Board	0.50	0.50	0.25	0.25	1.00	1.00	0.50	0.00	1.00	1.00	0.53500	**87**

69	Surendranath Park	0.50	0.25	0.00	0.00	1.00	1.00	0.25	0.00	1.00	1.00	0.41000	**106**
70	Old Mission Church	1.00	1.00	0.75	0.50	0.50	1.00	0.25	1.00	1.00	1.00	0.80000	**17**
71	Manohar Das Tarag	0.75	0.25	0.50	0.25	0.75	1.00	0.25	0.25	1.00	1.00	0.54375	**82**
72	Indian Association	0.75	0.75	0.25	0.50	0.50	0.50	0.25	0.50	1.00	0.75	0.55875	**79**
73	Firingi Kali Temple	1.00	0.50	0.00	0.00	0.75	1.00	0.50	0.50	1.00	0.75	0.54875	**81**
74	Sraddhananda Park	0.25	0.25	0.00	0.00	0.50	1.00	0.25	0.00	1.00	0.50	0.30125	**119**
75	Church of Our Lady of Dolours	1.00	0.25	0.25	0.25	0.75	1.00	0.25	0.50	1.00	1.00	0.56750	**74**
76	Raja Subodh Mullick Square	1.00	0.50	0.50	0.75	0.00	0.00	0.00	0.50	1.00	0.75	0.51000	**91**
77	Calcutta Technical School	1.00	0.75	0.50	0.75	0.00	0.00	0.00	0.50	1.00	1.00	0.56000	**78**
78	Maulana Azad College	0.50	0.50	0.25	0.25	0.75	1.00	0.50	0.50	1.00	1.00	0.54250	**83**
79	Niratan Sarkar Medical College	1.00	0.75	0.25	0.50	1.00	1.00	0.75	0.75	1.00	1.00	0.75750	**30**
80	St. James' Church	1.00	1.00	0.75	0.50	0.75	1.00	0.50	1.00	1.00	1.00	0.84125	**14**
81	St. James' School	1.00	0.50	0.25	0.25	0.75	1.00	0.25	0.50	1.00	1.00	0.60875	**65**
82	Nona Pukur Tram Depot	0.75	0.50	0.00	0.00	0.00	0.00	0.00	0.50	1.00	1.00	0.30875	**118**
83	Lower Circular Road Cemetery	1.00	0.75	0.50	0.25	0.50	0.00	0.25	1.00	1.00	1.00	0.59125	**71**
84	Haji Md. Mohsin Square	0.50	0.25	0.00	0.00	0.50	1.00	0.25	0.00	0.75	0.75	0.34250	**115**
85	Indian Museum	1.00	1.00	0.75	1.00	1.00	0.50	1.00	1.00	0.75	1.00	0.90750	**5**
86	Y.M.C.A. Chowringhee	0.75	0.50	0.75	0.25	0.50	0.75	0.25	0.50	0.75	0.75	0.56750	**75**
87	Bible Society	1.00	0.75	1.00	0.75	0.75	0.50	0.25	1.00	0.75	1.00	0.79250	**19**
88	Royal Calcutta Turf Club	1.00	0.50	1.00	0.75	1.00	1.00	0.50	0.75	0.50	0.50	0.80000	**18**
89	Virginia House - I.T.C	1.00	0.50	0.50	0.50	0.75	0.50	0.50	0.50	0.75	0.75	0.62500	**63**
90	Kanak Building	1.00	0.75	1.00	1.00	1.00	0.50	0.75	1.00	0.75	0.75	0.87500	**10**
91	Palace Court	0.75	0.50	0.75	0.75	0.75	0.50	0.50	1.00	0.75	0.75	0.68375	**46**
92	South Park Street Cemetery	1.00	1.00	1.00	0.75	0.75	0.75	0.50	1.00	1.00	1.00	0.88375	**8**
93	Kolkata Maidan	1.00	1.00	0.00	0.00	0.00	1.00	1.00	1.00	1.00	0.75	0.62125	**64**
94	Race Course, Maidan	1.00	1.00	0.00	0.00	0.00	1.00	0.50	0.50	1.00	0.75	0.55625	**80**
95	Scottish Cemetery	1.00	0.75	0.50	0.50	0.25	0.50	0.50	1.00	1.00	1.00	0.66625	**49**
96	Dalhousie Institute	1.00	1.00	0.50	0.75	0.50	0.50	0.50	1.00	1.00	0.75	0.75750	**29**
97	Birla Industrial and Technological Museum	0.75	0.50	0.75	1.00	1.00	0.50	0.50	0.75	1.00	1.00	0.74375	**34**
98	Calcutta Club	0.75	1.00	1.00	0.75	1.00	0.50	0.50	0.75	0.75	0.75	0.80875	**16**
99	Asutosh College	0.75	0.75	0.50	0.50	0.75	1.00	0.25	0.50	0.75	1.00	0.66750	**48**
100	Bhawanipur Police Station	1.00	0.50	0.25	0.25	0.50	1.00	0.25	0.00	0.75	0.10	0.51100	**90**
101	Alipore Bridge	0.75	0.25	0.25	0.25	0.75	1.00	0.25	0.25	0.50	0.50	0.47500	**98**
102	Hastings House	1.00	1.00	0.50	0.50	0.75	0.25	0.75	0.50	0.50	0.50	0.68125	**47**
103	The Agri-horticultural Society of India	1.00	0.25	0.00	0.00	1.00	1.00	0.25	0.00	0.50	0.50	0.45750	**101**
104	St. Stephen's Church	1.00	0.50	0.50	0.50	0.75	1.00	0.25	0.25	1.00	1.00	0.66000	**51**
105	Kiddirpur Post Office	1.00	0.50	0.50	0.50	0.25	1.00	0.25	0.50	1.00	1.00	0.62625	**62**
106	West Bengal Survey Building	0.75	0.50	0.25	0.25	0.50	1.00	0.25	0.00	1.00	0.75	0.50125	**93**

107	Greek Orthodox Church	1.00	0.50	0.75	0.50	0.75	1.00	0.25	1.00	0.75	0.50	0.71625	**39**
108	Mahanirvan Math	0.75	0.50	0.50	0.50	0.75	1.00	0.25	0.25	1.00	0.50	0.60125	**67**
109	Tollygunge Ghari Ghar	0.75	0.25	0.25	0.00	0.25	0.25	0.00	0.25	1.00	1.00	0.33500	**116**
110	State Archaeological Museum	0.50	0.50	0.50	0.50	1.00	1.00	0.50	0.50	0.25	0.00	0.57375	**73**
111	Gwalior Monument	1.00	0.75	0.75	0.50	0.50	1.00	0.25	0.75	0.50	0.75	0.71625	**40**
112	Girish Mancha	0.75	0.25	0.50	1.00	0.50	1.00	0.50	1.00	1.00	1.00	0.68500	**44**
113	Millennium Park	0.25	0.25	0.25	0.00	0.75	0.75	0.00	0.75	0.75	0.75	0.36750	**110**
114	Alipore Zoological Garden	1.00	0.50	0.50	0.00	0.75	0.75	0.00	0.50	0.50	0.50	0.53250	**88**
115	Rabindra Sarobar	0.75	0.25	0.50	0.00	0.50	0.50	0.50	0.50	0.75	0.50	0.44125	**104**
116	Rabindra Sadan	1.00	0.75	0.75	0.75	1.00	0.75	0.75	1.00	0.25	0.00	0.78875	**23**
117	Science City	0.75	0.50	0.50	0.50	0.75	0.50	0.50	0.50	0.00	0.00	0.53125	**89**
118	Asiatic Society	1.00	1.00	0.75	0.75	0.75	0.75	0.50	1.00	1.00	1.00	0.85000	**13**
119	National Library	1.00	1.00	1.00	0.50	1.00	0.50	0.50	0.75	0.50	0.25	0.79000	**22**
120	Netaji Bhawan	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.25	0.00	0.47375	**99**
121	Kalighat Temple	1.00	0.50	0.75	0.50	1.00	0.50	0.25	0.50	1.00	1.00	0.68500	**44**

Annexure II – Grey Relational Analysis

Ranking by Experts (In 1-5 Scale)				
	Expert 01 (Dr. Utpal Roy)	Expert 02 (Ar. Sumon Gupta)	Expert 03 (Subham Pramanick)	Expert 04 (Indranil Maity)
Parameters (Considering Equal Weightage)	**0.25**	**0.25**	**0.25**	**0.25**
Socio Economic Significance	3	3	3	3
Architectural Significance	2	4	1	2
Proximity	5	5	4	5
Integrity	4	2	5	4
Historical Significance	1	1	2	1

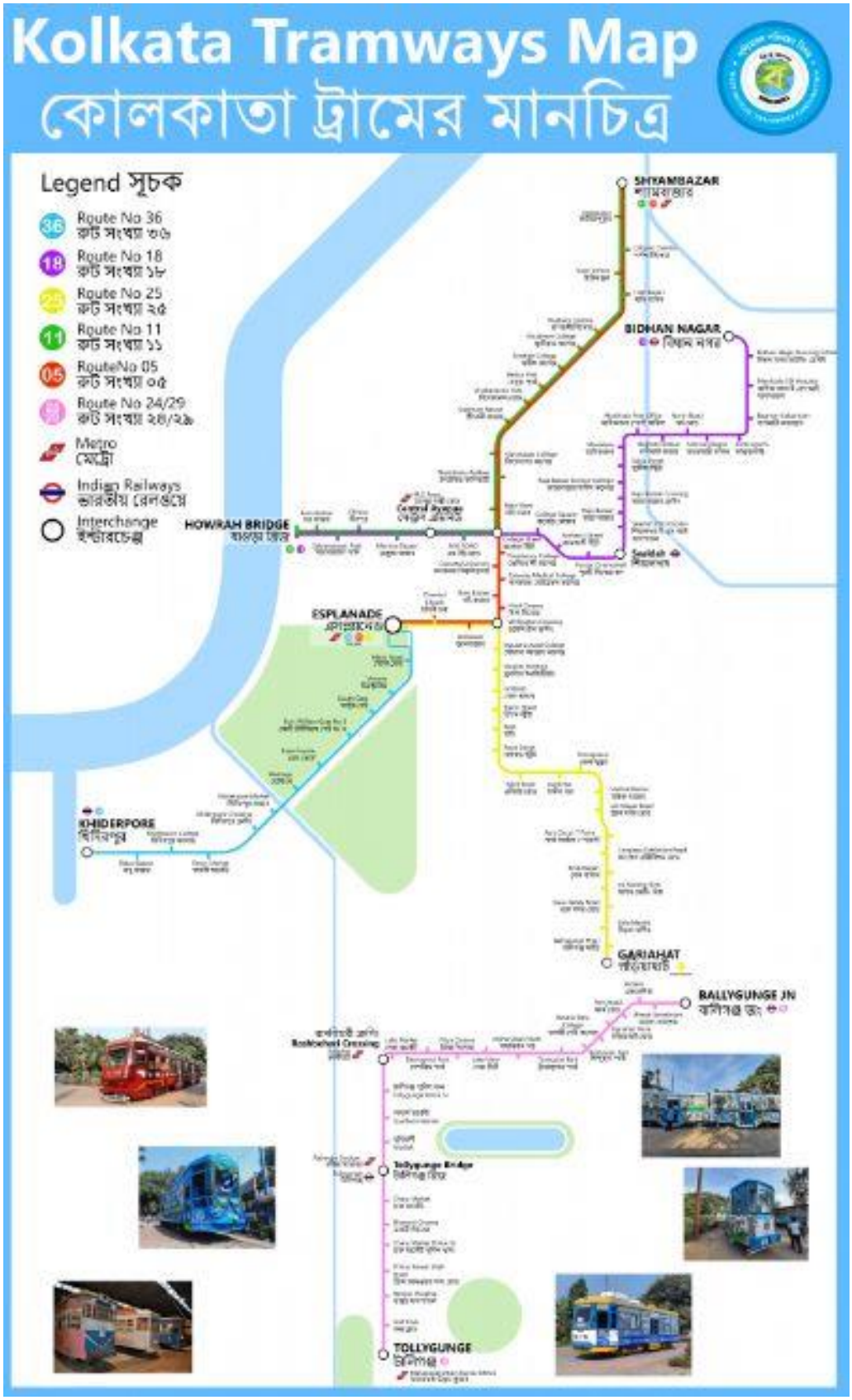
Normalized Value			
Expert 01 (Dr. Utpal Roy)	Expert 02 (Ar. Sumon Gupta)	Expert 03 (Subham Pramanick)	Expert 04 (Indranil Maity)
0.5	0.5	0.5	0.5
0.75	0.25	1	0.75
0	0	0.25	0
0.25	0.75	0	0.25
1	1	0.75	1

Deviation Sequence			
Expert 01 (Dr. Utpal Roy)	Expert 02 (Ar. Sumon Gupta)	Expert 03 (Subham Pramanick)	Expert 04 (Indranil Maity)
0.5	0.5	0.5	0.5
0.25	0.75	0	0.25
1	1	0.75	1
0.75	0.25	1	0.75
0	0	0.25	0

Grey Relational Coefficient			
Expert 01 (Dr. Utpal Roy)	Expert 02 (Ar. Sumon Gupta)	Expert 03 (Subham Pramanick)	Expert 04 (Indranil Maity)
0.5	0.5	0.5	0.5
0.6667	0.4	1	0.66667
0.3333	0.3333	0.4	0.33333
0.4	0.6667	0.3333333	0.4
1	1	0.6666667	1

Parameters	GRG	RANK
Socio Economic Significance	0.5	3
Architectural Significance	0.6833	2
Poximity	0.35	5
Integrity	0.45	4
Historical Significance	0.9167	1

Annexure III - Route Map, WBTC



Annexure IV - Questionnaire Survey Format

User Perception Survey Questionnaire

Hello everyone,

My name is **Ritam Samanta** and I am a **M. Plan (Transport Planning)** student at **SPA, Bhopal**. I am currently working on my thesis titled "**Revival of Tramways as a Sustainable Mode of Transport - Integration of Heritage Route Mapping. (A Case of Kolkata)**"
I would be grateful if you could take a few minutes to share your opinion by filling out this questionnaire form. The data collected would be for research purpose only.
Thank you

* Indicates required question

1. Email Id *

Skip to question 2

Personal Information

2. Name *

3. Age *

Mark only one oval.

- ◯ Below 18
- ◯ 19-35
- ◯ 36-50
- ◯ 51-65
- ◯ Above 65

4. Gender *

Mark only one oval.

- Male
- Female
- Transgender
- Other

5. Occupation *

Mark only one oval.

- Govt. Service
- Private Service
- Business
- Student
- House Wife
- Retired
- Unemployed
- Others

6. Frequency of Using Tram *

Mark only one oval.

- Daily
- Weekly
- Monthly
- Rarely

7. Purpose of Travel *

Mark only one oval.

- ◯ Work
- ◯ Business
- ◯ Educational
- ◯ Social
- ◯ Recreational
- ◯ Religious
- ◯ Tourist
- ◯ Others

8. Initial Origin

_____

9. Final Destination

_____

Skip to question 10

User Perception Information

10. 1. Please rate your opinion on **Accessibility** of Tram *

Mark only one oval.

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4

11. 2. Please rate your opinion on **Availability** of Tram *

Mark only one oval.

- 1
- 2
- 3
- 4

12. 3. Please rate your opinion on **Personal Safety** of Tram *

Mark only one oval.

- 1
- 2
- 3
- 4

13. 4. Please rate your opinion on **Convenience** of Tram (Amenities such as Charging Point, Wi-Fi, Fan, Display Board, AC etc.) *

Mark only one oval.

- 1
- 2
- 3
- 4

14. 5. Please rate your opinion on **Comfort** on Tram *

Mark only one oval.

- 1
- 2
- 3
- 4

15. 6. Tram should removed from Kolkata? *

Mark only one oval.

- ◯ No
- ◯ May Be
- ◯ Yes

16. 7. Trams are still an Important mode of Public Transport in Kolkata today? *

Mark only one oval.

- ◯ No
- ◯ May Be
- ◯ Yes

17. 8. Tram should operational in Heritage route only in Kolkata? *

Mark only one oval.

- ◯ No
- ◯ May Be
- ◯ Yes

18. 9. Tram should operational in new routes also in Kolkata? *

Mark only one oval.

- ◯ No
- ◯ May Be
- ◯ Yes

19. 10. Does Tram service is better than Metro service? *

Mark only one oval.

- ◯ No
- ◯ Maybe
- ◯ Yes

20. 11. Does modernized Tram attract citizens to use it? *

Mark only one oval.

- ◯ No
- ◯ May Be
- ◯ Yes

21. 12. Are you willing to pay extra fare for Modernized Tram? *

Mark only one oval.

- ◯ No
- ◯ May Be
- ◯ Yes

22. Suggestions / Comments , If any

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Stakeholder Questionnaire Survey (User Perception)

Name of Surveyor- Date - Time - Sl. No. -

INTERVIEW									
Personal Information									
Name				Age		Gender			
Occupation									
1. Govt Service, 2. Pvt. Service, 3. Business, 4. Student, 5. House wife, 6. Retired, 7. Unemployed, 8. others									
Frequency of Using tram	Daily		Weekly		Monthly		Rarely		
Purpose of Travel									
1. Work, 2. Business, 3. Educational, 4. Social, 5. Recreational, 6. Religious, 7. Tourist, 8. others									
Initial Origin				Final Destination					
User Perception Information									
1. Your opinion on accessibility of Tram (Ease of Boarding & Alighting tram)									
							Lack of stopping time?		
							Unsafe junction, crossing?		
Please rate your Opinion (1-4) (Poor - Best)	**1**		**2**		**3**	**4**			
2. Your opinion on availiability of Tram									
							Schedule maintained?		
							State the issues if any ?		
Please rate your Opinion (1-4) (Poor - Best)	**1**		**2**		**3**	**4**			
3. Your opinion on personal safety on Tram									
							Pick Pocketing?		
							safe during night?		
Please rate your Opinion (1-4) (Poor - Best)	**1**		**2**		**3**	**4**			
4. Your opinion on Convenience (Amenities such as charging point, fan, Wifi, Display board, AC) on Tram									
							Poor floor quality?		
							Lack of amenities, signage?		
Please rate your Opinion (1-4) (Poor - Best)	**1**		**2**		**3**	**4**			
5. Your opinion on Comfort on Tram									
							Poor quality of seat?		
							Lack of Cleanliness?		
							Lack of leg space?		
Please rate your Opinion (1-4) (Poor - Best)	**1**		**2**		**3**	**4**			
6. Tram should removed from Kolkata?									
Please rate your Opinion (1-4) (No -May be - Yes)	**1**		**2**		**3**	**4**			
7. Tram should operational in heritage route only in Kolkata?									
Please rate your Opinion (1-4) (No -May be - Yes)	**1**		**2**		**3**	**4**			
8. Tram should operational in new routes in Kolkata?									
Please rate your Opinion (1-4) (No -May be - Yes)	**1**		**2**		**3**	**4**			
9. Does tram service is better than metro service?									
Please rate your Opinion (1-4) (No -May be - Yes)	**1**		**2**		**3**	**4**			
10. Are you willing to pay extra fare for Modernised Tram?									
Please rate your Opinion (1-4) (No -May be - Yes)	**1**		**2**		**3**	**4**			

Note: As a part of our academic programme **(Final year Post Graduation Thesis)**, this survey is intended to know about the tramway services operating in the city of **Kolkata, West Bengal.** The survey form consists of a few questions and the answers provided by you will solely be used for academic/study purpose. Your response for the same will help a lot for the study and would be appreciated.

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Stakeholder Questionnaire Survey (Expert)

Name of Surveyor- Date - Time - Sl. No. -

Stakeholder Name		Organization Name	
INTERVIEW			
Q.1	Trams operated successfully for the first 100 years, but after 1969, they started to deteriorate. What is the reason behind it?		
Ans.			
Q.2	Does its utility (usefulness) now differ from when the tram system was established?		
Ans.			
Q.3	What was the reason that the tram's route kilometer drops from 70km to 20km currently?		
Ans.			
Q.4	What will be the alternative for tram operation? (**Like heritage route, operating as it is, perspective of Govt, Traffic management, Priority treatment to tram, congestion pricing, no on street parking)** Is it practical? Will it help? What do you think?		
Ans.			
Q.5	Have there ever been any activity proposals for tram development that failed to pass?		
Ans.			
Q.6	After the tram routes on the Howrah Bridge were closed, what happened? Benefits and Drawbacks		
Ans.			

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Stakeholder Questionnaire Survey (Operator)

Name of Surveyor- Date - Time - Sl. No. -

Stakeholder Name		Organization Name	
INTERVIEW			
Q.1	Is there any competition between tram and your transport system ?		
Ans.			
Q.2	Is sufficient ridership achieved when operating on tram routes?		
Ans.			
Q.3	Any problems faced when operating on tram routes?		
Ans.			
Q.4	Is your transport system improved when the tram routes closed?		
Ans.			
Q.5	How does the cost of operating your services compare to the cost of operating tram services?		
Ans.			
Q.6	Have you noticed any changes in the number of passengers using your service instead of the tram?		
Ans.			

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Stakeholder Questionnaire Survey (Individual Professional)

Name of Surveyor- Date - Time - Sl. No. -

Stakeholder Name		Organization Name	
INTERVIEW			
Q.1	Trams operated successfully for the first 100 years, but after 1969, they started to deteriorate. What is the reason behind it?		
Ans.			
Q.2	Are trams still an important mode of public transport in Kolkata today?		
Ans.			
Q.3	What's the issue if the tram is running on the road? Your perspective.		
Ans.			
Q.4	What will be the alternative for tram operation? (Like heritage route, operating as it is, Closing of tram, Operating on zero emission zone, Traffic management, Priority treatment to tram,) Is it practical? What do you think?		
Ans.			
Q.5	Would you prefer Trams replacing Bus/Auto/Mini bus where road width is minimum?		
Ans.			

Note: As a part of our academic programme **(Final year Post Graduation Thesis)**, this survey is intended to know about the tramway services operating in the city of **Kolkata, West Bengal.** The survey form consists of a few questions and the answers provided by you will solely be used for academic/study purpose. Your response for the same will help a lot for the study and would be appreciated.

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Road Network Inventory Survey

Name of Surveyor- Date - Time - Sl. No. -

Road Name	ROW (m)	LEFT HAND SIDE OF THE ROAD: Carriageway (In M)	Road Surface		Footpath		Service Road	Cycle Lane	Reserve shoulder	Adjoining Landuse		Drain (yes/no)	Street Light (yes/no)		Parking Facilities				Bus Facilities				Road side Encroachment		Road Marking	Existing TSM Measures(Like Oneway etc.)	Tram	
		Width (m)	Type	Quality	Width (m)	Obstruction (if any)	Width (M)	Width (M)	Width (m)	Landuse Type	No. of floors (G, G+1, G+2, G+3	Covered/Uncovered	Type	Location	On-street/ Off-street parking	Length of Parking (M)	Parking Status (Free/ Paid/ UA)	Vehicle Types - Car/ 2W/other	Bus Route Y/N	Bus Bay Y/N	No. Of Bus Stops	No. of Taxi/Auto	Type - Vendor/ Parking/ Informal	Heavy/ Moderate/	Yes/ No		Tram Tracks Y/N	Overhead Electric line Y/N

Road Name	MEDIAN		RIGHT HAND SIDE OF THE ROAD: Carriageway (In M)	Surface Type		Footpaths		Service Road	Cycle Lane	Reserve shoulder	Adjoining Landuse		Drain (yes/no)	Street Light (yes/no)		Parking Facilities				Bus Facilities				Road side Encroachment		Road Marking	Existing TSM Measures(Like Oneway etc.)	Tram	
	Available (Y/N)	Width (m)	Width (m)	Type	Quality	Width (m)	Obstructions (if any)	Width (M)	Width (M)	Width of Shoulder	Landuse Type	No. of floors (G, G+1, G+2, G+3	Covered/Uncovered	Type	Location	On-street/ Off-street parking	Length for Parking (M)	Parking Status (Free/ Paid/ UA)	Vehicle Types - Car/ 2W/other	Bus Route Y/N	Bus Bay Y/N	No. Of Bus Stops	No. of Taxi/Auto	Type - Vendor/ Parking/ Informal	Heavy/ Moderate/	Yes/ No		Tram Tracks Y/N	Overhead Electric line Y/N

NOTE : LIST TO BE EXPANDED AS PER SITE CONDITIONS

TYPE OF LIGHTING	1. FLAMENT	2. FLOURESCENT	3. SODIUM	4. LED					
LOCATION OF LIGHTING	1. ON MEDIAN	2. ONE SIDE ONLY	3. BOTH SIDES						
TYPE OF ROAD SURFACE	1. WBM	2. BITUMEN	3. CEMENT CONCRETE						
QUALITY OF ROAD SURFACE	1. GOOD	2. FAR	3. POOR						
ADJOINING LANDUSE	1.RESIDENTIAL	2. COMMERCIAL	3. INDUSTRIAL	4. PUBLIC & SEMI PUBLIC	5. TRANSPORT	6. RECREATIONAL	7. AGRICULTURE	8. VACANT LAND	9. MIXED USE

Parking
UA- Unauthorised
A- Authorised

Note: As a part of our academic programme **(Final year Post Graduation Thesis)**, this survey is intended to know about the tramway services operating in the city of **Kolkata, West Bengal.** The survey form consists of a few questions and the answers provided by you will solely be used for academic/study purpose. Your response for the same will help a lot for the study and would be appreciated.

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On Board PT (Tram) Survey

Name of Surveyor- Date - Time - Sl. No. -

Location Name			DIRECTION FROM:			DIRECTION TO :				
Time	Initial Origin	Final Destination	Trip Purpose	Frequency of Travel	Travel Distance (Km)	Travel Time (Min.)	Travel Cost (Rs.)	Resident/Non Resident (KMC)	Occupation	Extra Fare Willing to Pay for Modernised Tram

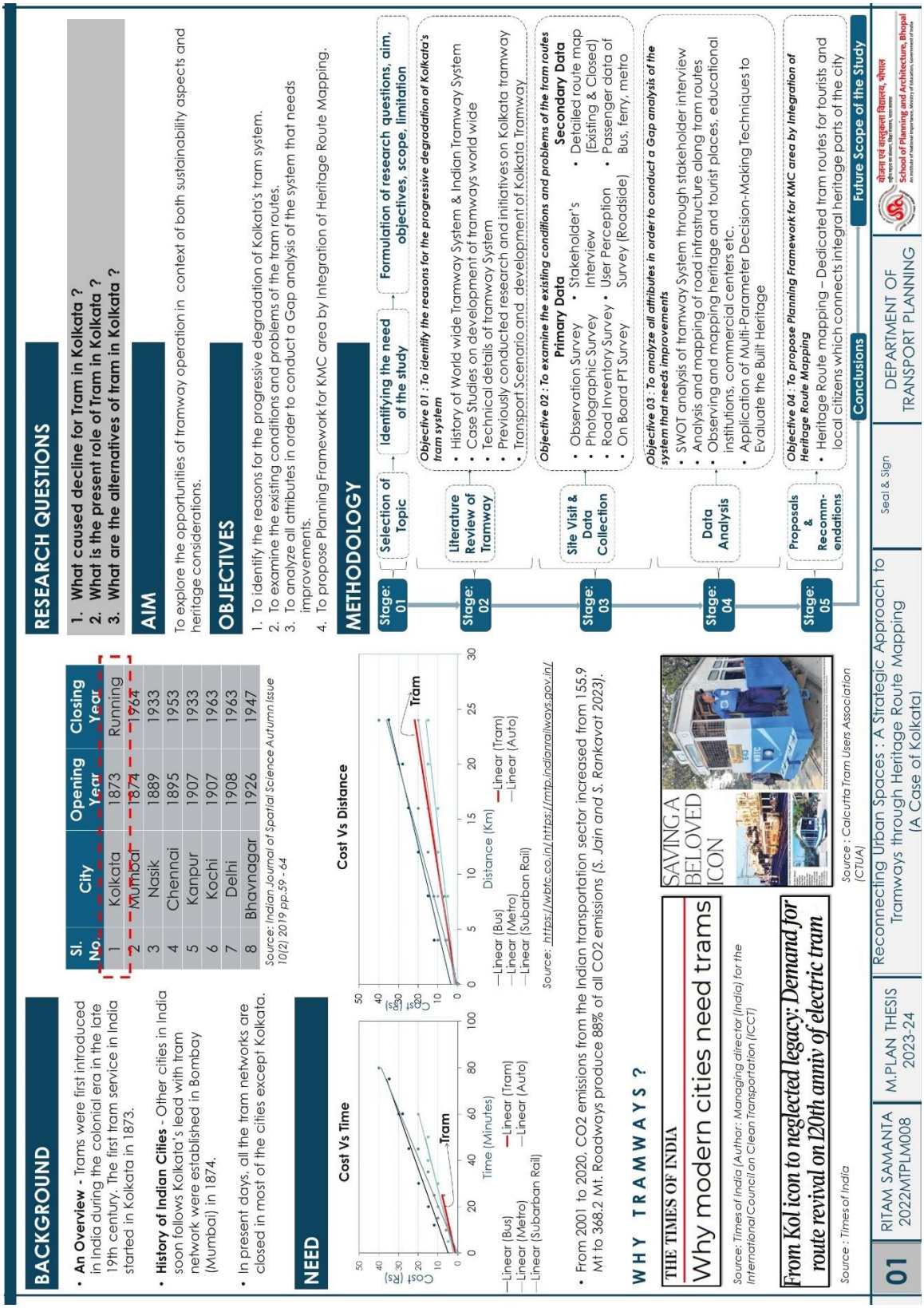
Purpose	Code
Work	1
Business	2
Education	3
Social	4
Recreation	5
Religious	6
Others	7
Tourist	8

Trip	Code
Daily	D
Weekly	W
Monthly	M
Yearly	Y

Occupatio
Govt Service
Private Service
Business
Student
Housewife
Retired
Unemployed

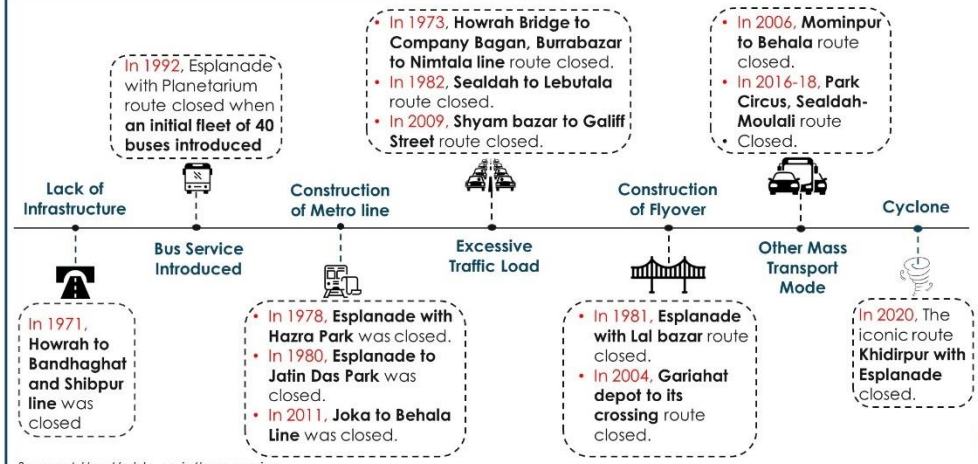
Note: As a part of our academic programme **(Final year Post Graduation Thesis)**, this survey is intended to know about the tramway services operating in the city of **Kolkata, West Bengal.** The survey form consists of a few questions and the answers provided by you will solely be used for academic/study purpose. Your response for the same will help a lot for the study and would be appreciated.

Annexure V - Presentation Sheet



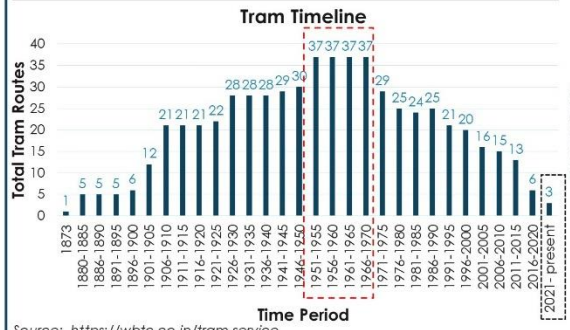
LITERATURE STUDY

What caused decline for Tram in Kolkata ?



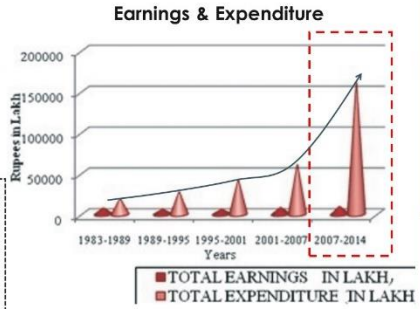
Source: https://wbtc.co.in/tram-service
DOI:10.15680/IJIRSET.2016.0505120

What is the present role of Tram in Kolkata ?



Source: https://wbtc.co.in/tram-service

- In 1969, Kolkata Tramway had **track length of 70.74 Km**
- Presently, **only 3 routes operational with track length of 20 Km**
- The daily ridership also rapidly decreased (from 1.6 lakh passengers per day in 2008 to **merely 15000 passengers per day, as of 2022)**



Source: Indian Journal of Spatial Science Autumn Issue, 10(2) 2019 pp 59 - 64

- The expenditure is **more than 30 times** of income during (2007-2014)

What are the alternatives of tram in Kolkata?

- A survey asking questions was carried out among Kolkata residents and tram users. A total **132 responses** received.

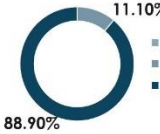
*** Tram should operational in new routes also in Kolkata?*

Source: Primary Survey by Author

"Tram network should be spreaded. It may not be the older ones but the modernized technology can be supported as it is very accessible."
- Tram user on Gariahat-Shyambazar route

*** Tram should removed from Kolkata?*

Source: Primary Survey by Author



"Tram is an alternative way out to establish sustainable mobility. In Kolkata, Tram is an emotional heritage too. World is moving towards zero emission and sustainable mobility concept - "Tram is one of the solution"
- Tram user on Tollygunge – Ballygunge (Route 24/29) route

Comparative Chart of Potential options for Tramway

		Closing of Tram routes	Operating Tram as it is	Operating Tram on Heritage route	Introducing New Tram routes	Operating Tram on Zero Emission Zone
Pros	Reduce traffic Congestion	■				■
	Speed Increase	■			■	■
	Passenger Capacity		■	■	■	■
	Low Operational cost		■	■		
	Attraction of Tourist		■	■		■
	Cultural Experience		■	■		
	Connectivity			■	■	
	Accessibility			■	■	■
	Goods Movement				■	■
	Reduce Pollution			■		■
	Modal Shift				■	
Cons	Eco Friendly	■				
	Reliable	■				
	Comfortable	■				
	Prone to Accident		■	■	■	■
	Restoration Cost		■	■	■	
	Limited area covered			■		
	High Traffic Zone				■	
	Implementation cost			■	■	■

CASE STUDY

Germany

A : Karlsruhe City Center

B : Regio Tram Kassel meets heavy rail

Learning –

- The **"tram–train"** approach is designed to solve this problem by linking urban tram and regional heavy railway infrastructure.
- The linkage provides a direct connection between the city center and its suburbs, which helps reduce travel time and increase efficiency.

Source: https://doi.org/10.3390/en15155685

Poland

Learning –

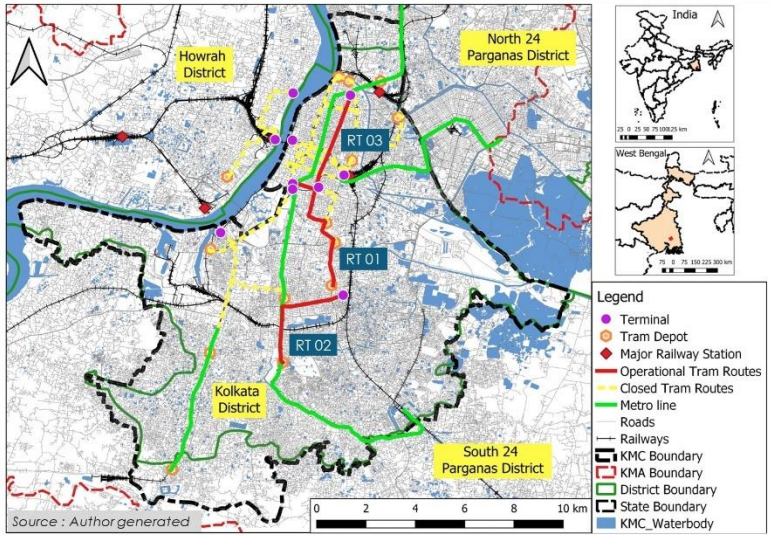
- *Reducing the Land Consumption of a Tram System*

- *Locating tram stops only one side*

- *Possibility of Serving Tram Stops Located on Island Platform*

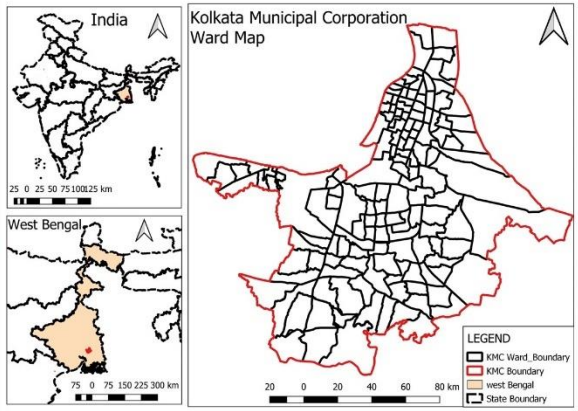
- *Mitigating the Negative Effects of Maintenance/Upgrading Works on a Tram Network*

Source: Journal of the Transportation Research Board, No. 2275



Source : Author generated

STUDY AREA



Source : Author generated

- Total Area : **205 sq. km**
- Total no. of Ward : **144**
- Population: **4,496,694** according to 2011 Census.
- Population Density : **21,935/ sq. km.**

Currently Operational Routes – **3 Routes**
- RT 01 - **8.45 Km**
- RT 02 - **6 Km**
- Rt 03 - **5.9 Km**

SITE VISIT & DATA COLLECTION

- **Road Network Inventory Survey (Total 9 routes)**

1. Ballygunge – Tollygunge **(Operational route)**
2. B.B.D Bag – Gariahat **(Operational route)**
3. B.B.D Bag – Shyam bazar **(Operational route)**
4. Howrah Bridge – Belgachia **(Closed route)**
5. Howrah Bridge – Bidhan Nagar **(Closed route)**
6. Khidirpore – Esplanade **(Closed route)**
7. B.B.D Bag – Bagbazar **(Closed route)**
8. B.B.D Bag – Raja bazar **(Closed route)**
9. Kalighat – Khidirpore **(Closed route)**

- **On Board PT Survey (At Tram)**

Total Sample Collected – **53**
- Ballygunge – Tollygunge **(Operational route) – 22 nos.**
- B.B.D Bag – Gariahat **(Operational route) - 14 nos.**
- B.B.D Bag – Shyam bazar **(Operational route) – 17 nos.**

- **Stakeholder Questionnaire Survey (Expert Interview)**

Total Sample Collected – **03**
1. **Dr. Utpal Roy** (Associate Professor), Dept. of Geography, University of Calcutta
2. **Ar. Sumon Gupta** (Architect & Planner), Aakriti, Kolkata
3. **Ar. Diptiman Samanta** (Architect & Planner), Aakriti, Kolkata

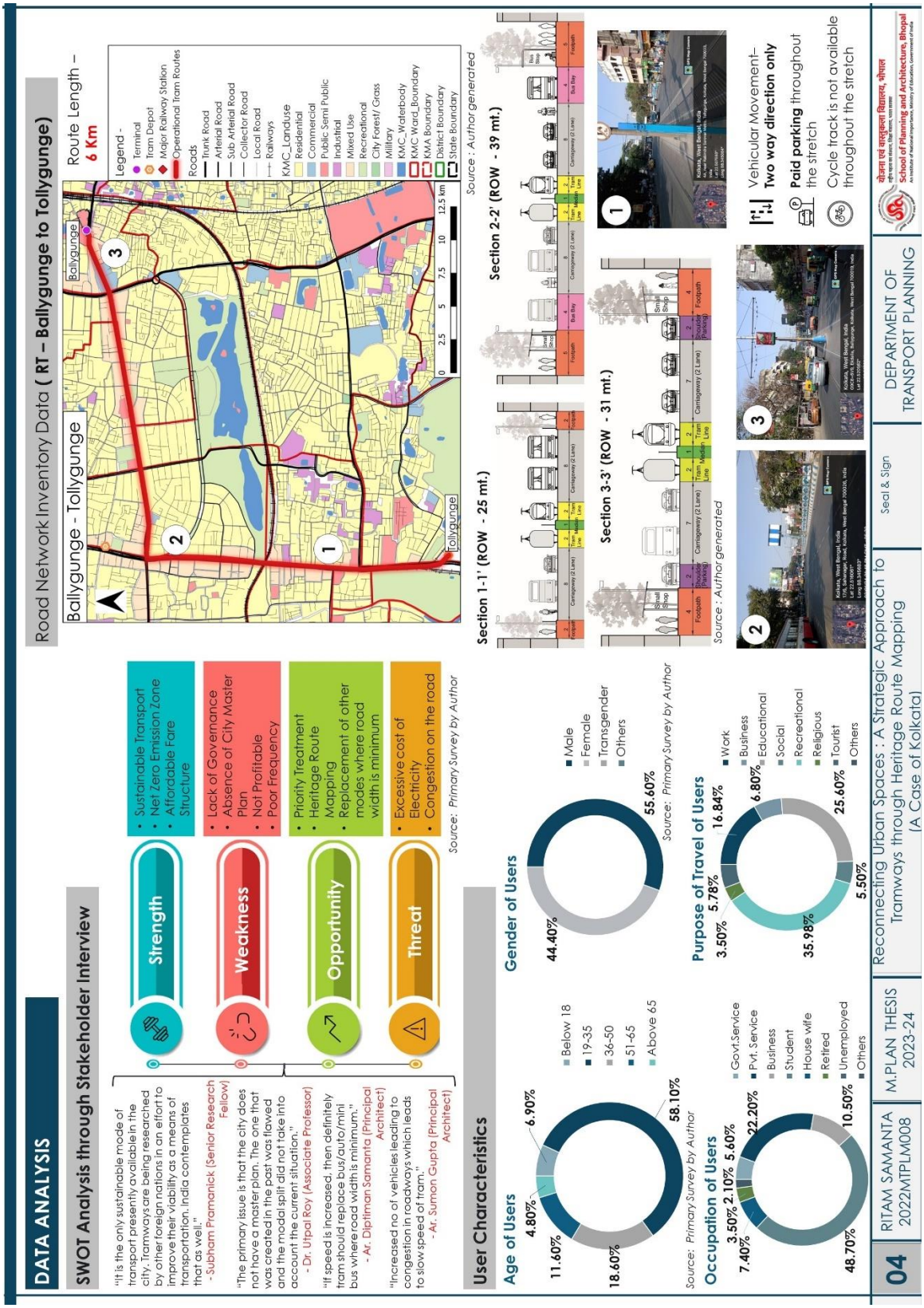
- **Stakeholder Questionnaire Survey (Individual Professional Interview)**

Total Sample Collected – **03**
1. **Subham Pramanick** (Senior Research Fellow) , Dept. of Geography, Ballygunge Science College
2. **Indranil Maity** (Research Assistant), Dept. of Geography, Ballygunge Science College
3. **Fayaz Ahmed** (Manager), RITES Ltd.

- **User Perception Survey**

Total Sample Collected – **79**

03	RITAM SAMANTA 2022MTPLM008	M.PLAN THESIS 2023-24	Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping (A Case of Kolkata)	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal


DATA ANALYSIS
SWOT Analysis through Stakeholder Interview
"It is the only sustainable mode of transport presently available in the city. Tramways are being researched by other foreign nations in an effort to improve their viability as a means of transportation. India contemplates that as well."
- Subham Pramanick (Senior Research Fellow)
"The primary issue is that the city does not have a master plan. The one that was created in the past was flawed and the modal split did not take into account the current situation."
- Dr. Utpal Roy (Associate Professor)
"If speed is increased, then definitely tram should replace bus/auto/mini bus where road width is minimum."
- Ar. Diptiman Samanta (Principal Architect)
"Increased no of vehicles leading to congestion in roadways which leads to slow speed of tram."
- Ar. Suman Gupta (Principal Architect)
Strength
Sustainable Transport
Net Zero Emission Zone
Affordable Fare Structure
Weakness
Lack of Governance
Absence of City Master Plan
Not Profitable
Poor Frequency
Opportunity
Priority Treatment
Heritage Route Mapping
Replacement of other modes where road width is minimum
Threat
Excessive cost of Electricity
Congestion on the road
Source: Primary Survey by Author
User Characteristics
Age of Users
Below 18
19-35
36-50
51-65
Above 65
6.90%
4.80%
11.60%
18.60%
58.10%
Source: Primary Survey by Author
Occupation of Users
Govt.Service
Pvt. Service
Business
Student
House wife
Retired
Unemployed
Others
3.50%
2.10%
5.60%
7.40%
22.20%
10.50%
48.70%
Gender of Users
Male
Female
Transgender
Others
44.40%
55.60%
Source: Primary Survey by Author
Purpose of Travel of Users
Work
Business
Educational
Social
Recreational
Religious
Tourist
Others
3.50%
5.78%
16.84%
6.80%
35.98%
25.60%
5.50%
Road Network Inventory Data (RT – Ballygunge to Tollygunge)
Ballygunge - Tollygunge
Route Length – 6 Km
Legend -
Terminal
Tram Depot
Major Railway Station
Operational Tram Routes
Roads
Trunk Road
Arterial Road
Sub Arterial Road
Collector Road
Local Road
Railways
KMC_Landuse
Residential
Commercial
Public Semi Public
Industrial
Mixed Use
Recreational
City Forest/ Grass
Military
KMC_Waterbody
KMC Ward_Boundary
KMA Boundary
District Boundary
State Boundary
Ballygunge
Tollygunge
0 2.5 5 7.5 10 12.5 km
Source : Author generated
Section 1-1' (ROW - 25 mt.)
Section 2-2' (ROW - 39 mt.)
Section 3-3' (ROW - 31 mt.)
Source : Author generated
Vehicular Movement– Two way direction only
Paid parking throughout the stretch
Cycle track is not available throughout the stretch
04
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2022MTPLM008
M.PLAN THESIS
2023-24
Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping
(A Case of Kolkata)
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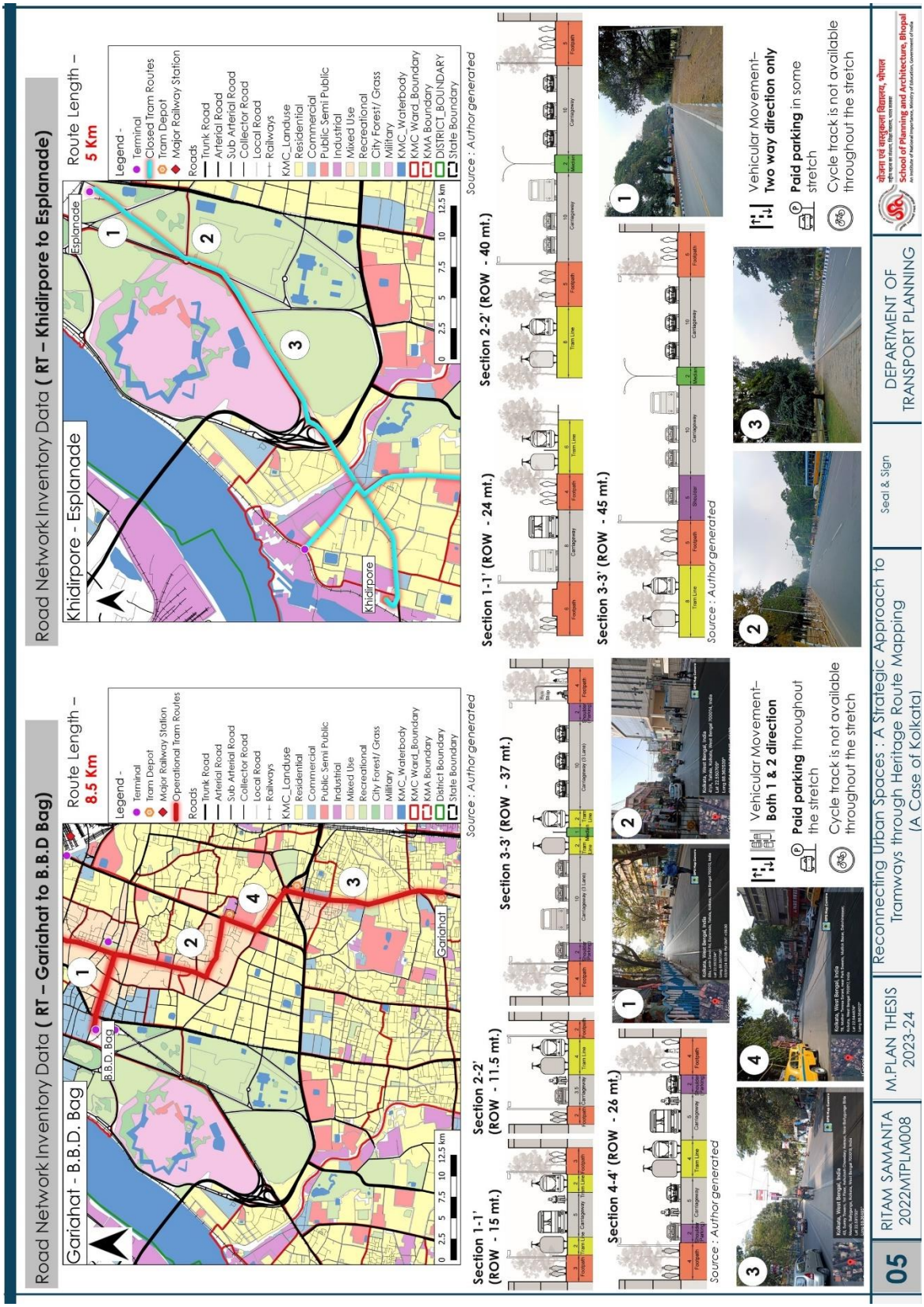
Road Network Inventory Data (RT – Gariahat to B.B.D Bag)
Gariahat - B.B.D. Bag
Route Length – 8.5 Km
Road Network Inventory Data (RT – Khidirpore to Esplanade)
Khidirpore - Esplanade
Route Length – 5 Km
Source : Author generated
Section 1-1' (ROW - 15 mt.)
Section 2-2' (ROW - 11.5 mt.)
Section 3-3' (ROW - 37 mt.)
Section 4-4' (ROW - 26 mt.)
Section 1-1' (ROW - 24 mt.)
Section 2-2' (ROW - 40 mt.)
Section 3-3' (ROW - 45 mt.)
Vehicular Movement– Both 1 & 2 direction
Paid parking throughout the stretch
Cycle track is not available throughout the stretch
Vehicular Movement– Two way direction only
Paid parking in some stretch
Cycle track is not available throughout the stretch
05
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2023-24
Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping
(A Case of Kolkata)
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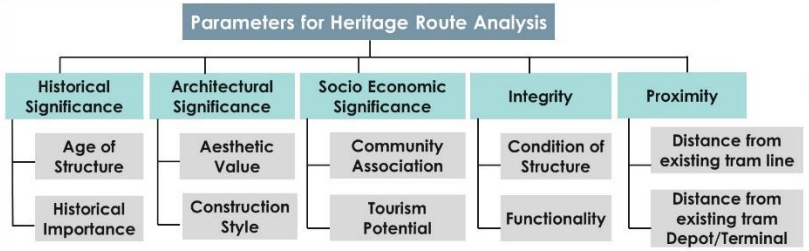
Heritage Site Listing

Total listed Site - **121**

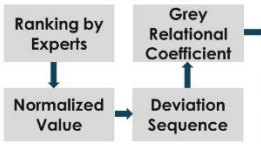
Parameters for Heritage Route Analysis



Grey Relational Analysis (GRA) for Ranking of Parameters

List of Experts :

1. ***Dr. Utpal Roy*** *(Associate Professor), Dept. of Geography, University of Calcutta*
2. ***Ar. Sumon Gupta*** *(Architect & Planner), Aakriti, Kolkata*
3. ***Subham Pramanick****, (Senior Research Fellow) Dept. of Geography, Ballygunge Science College*
4. ***Indranil Maity*** *(Research Assistant), Dept. of Geography, Ballygunge Science College*



Parameters	GRG	RANK
Socio Economic Significance	0.5	3
Architectural Significance	0.6833	2
Proximity	0.35	5
Integrity	0.45	4
Historical Significance	0.9167	1

Weightage distribution among Parameters using Rank Sum Method (RSM)

- Weightage has been divided using Rank Sum Method (RSM), and it is distributed among 5 parameters.
- Then weightages are equally distributed among sub parameters under each criterion.

Rank Sum Method

Parameter	Rank	Reverse Rank	Weightage
Historical Significance (P1)	1	5	**0.33**
Architectural Significance (P2)	2	4	**0.27**
Socio Economic Significance (P3)	3	3	**0.20**
Integrity (P4)	4	2	**0.13**
Proximity (P5)	5	1	**0.07**
By Using Rank Sum		15	1.00

Parameter	Weightage (Parameter)	Sub Parameter	Weightage (Sub Parameter)
Historical Significance (P1)	**0.33**	Age of the Structure (P11)	**0.165**
		Association Involved (P12)	**0.165**
Architectural Significance (P2)	**0.27**	Aesthetic value (P21)	**0.135**
		Style of Construction (P22)	**0.135**
Socio Economic Significance (P3)	**0.2**	Community Association (P31)	**0.1**
		Tourism Potential (P32)	**0.1**
Integrity (P4)	**0.13**	Condition of Structure (P41)	**0.065**
		Functionality (P42)	**0.065**
Proximity (P5)	**0.07**	Distance from existing tram line (P51)	**0.035**
		Distance from existing tram Depot/Terminal (P52)	**0.035**

Rating of Built Heritage (5 – Likert Scale)

Sl. No.	Sub - Parameter	Very Good (1.00)	Good (0.75)	Fair (0.50)	Poor (0.25)	Very Poor (0.00)
1	Age of the Structure (P11)	1700-1800	1800-1900	1900-1990	Post 1990	None
2	Association Involved (P12)	International	National	Regional	Local	None
3	Aesthetic value (P21)	Exceptional Architectural Detail	Notable Style of Architecture	Average Detailing	Poor Detailing	Absence of details
4	Style of Construction (P22)	Unique style	Well designed & notable design	Absence of Notable style	Poorly designed	Not well designed, unique and notable
5	Community Association (P31)	The structure has a solid historical association with public use	The structure has a strong historical association However, the structure no longer serves as an essential part of the community	The structure has a limited historical association with the neighborhood	The local community knows the structure	No community association in terms of its function or age.
6	Tourism Potential (P32)	Internationally Important	Nationally Impprtant	Regionally Important	Locally Important	Has potential for tourist destination
7	Condition of Structure (P41)	No maintenance required	Small amount restoration required	It needs quite a bit of work	Extensive repairs and restoration required	Not viable to retain the property
8	Functionality (P42)	The structure has maintained its original function	Adaptive reuse	function has changed	function completely changed	Structure is in abandoned state
9	Distance from existing tram line (P51)	(0-5) Km	(6-10) Km.	(11-15) Km.	(16-20) Km.	More than 20 Km.
10	Distance from existing tram Depot/Terminal (P52)	(0-10) Km	(11-20) Km	(21-30) Km	(31-40) Km	More than 40 Km

To get the rank of all heritage sites, the **Weighted Sum Method (WSM)** is used to calculate each structure's score. It is calculated by using the following equation,

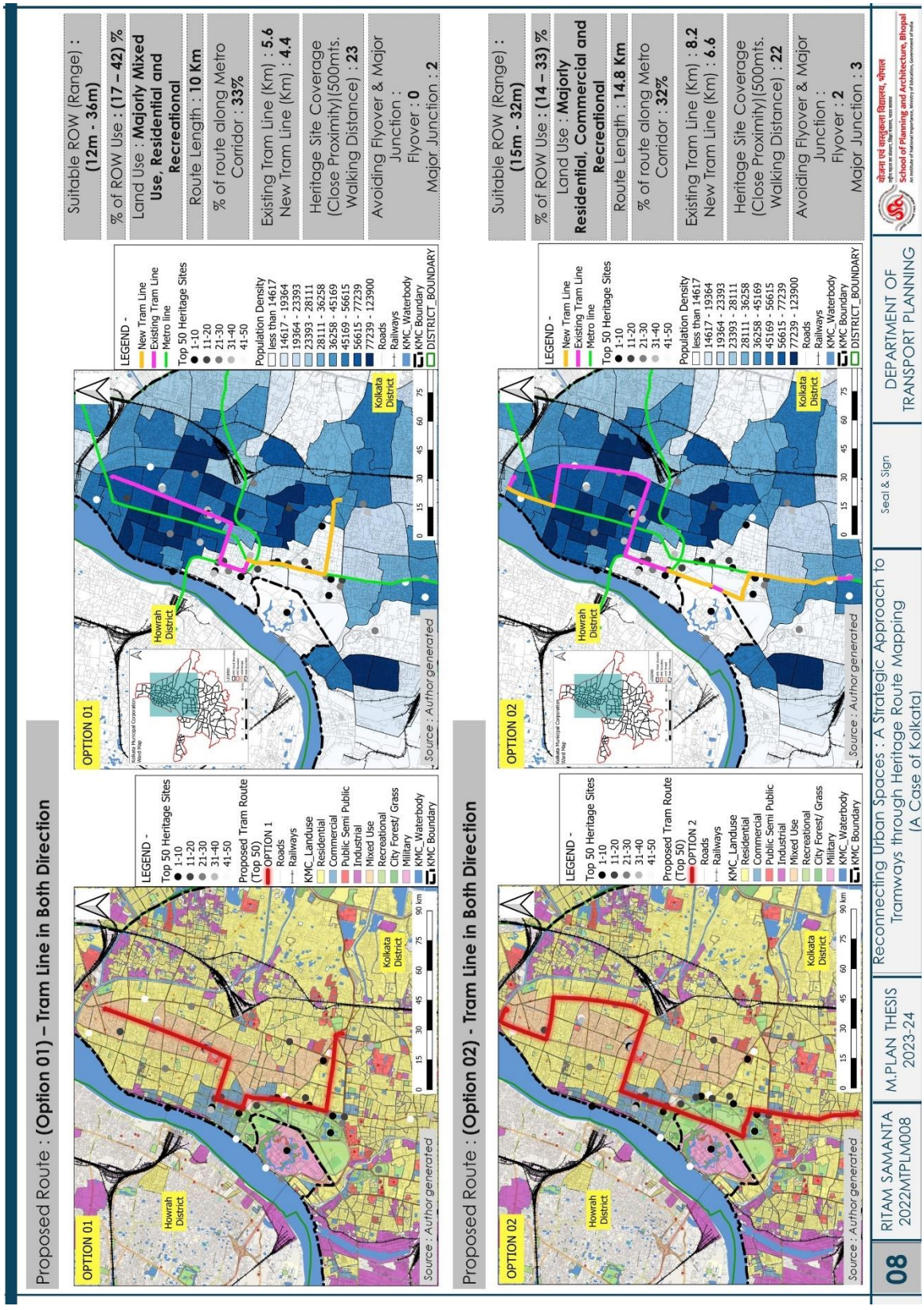
$$Pi^{\text{WSM Score}} = \sum w_i \, x \, pi$$

Where,
wi = relative weight of parameter or sub-Parameter
pi = performance value of each structure

06	RITAM SAMANTA 2022MTPLM008	M.PLAN THESIS 2023-24	Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping (A Case of Kolkata)	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Rating of Heritage Sites through WSM Method

Sl. No.	Main Parameter	Historical Significance (P1)		Architectural Significance (P2)		Socio Economic Significance (P3)		Integrity (P4)		Proximity (P5)		WSM Score	Rank
	Sub Parameter	Age of the Structure (P11)	Association Involved (P12)	Aesthetic value (P21)	Style of Construction (P22)	Community Association (P31)	Tourism Potential (P32)	Condition of Structure (P41)	Functionality (P42)	Distance from existing tram line (P51)	Distance from existing tram Depot/Termin al (P52)		
	Weightage Value	0.165	0.165	0.135	0.135	0.1	0.1	0.065	0.065	0.035	0.035		
1	Victoria Memorial	0.75	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.95875	1
2	Fort William	1.00	1.00	0.75	0.75	1.00	1.00	1.00	0.75	0.50	0.50	0.88125	9
3	Howrah Bridge	0.75	1.00	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.50	0.91625	4
4	Princep Ghat	1.00	0.50	0.50	0.75	1.00	1.00	0.75	1.00	0.75	0.75	0.78250	24
5	Birla Planetorium	0.50	0.50	1.00	1.00	1.00	1.00	0.25	1.00	0.75	0.75	0.76875	26
6	St. Paul Cathedral	1.00	1.00	0.75	1.00	1.00	1.00	1.00	1.00	0.75	0.75	0.94875	2
7	Shahid Minar	1.00	0.75	0.50	0.75	1.00	0.75	1.00	1.00	1.00	1.00	0.83250	15
8	Raj Bhawan	1.00	1.00	1.00	1.00	1.00	0.75	1.00	0.75	0.75	0.75	0.94125	3
9	Sovabazar Rajbari	1.00	0.50	0.75	0.75	1.00	1.00	1.00	0.50	0.75	0.50	0.79125	20
10	Writers Building	1.00	0.75	1.00	1.00	1.00	0.75	0.75	0.75	1.00	0.75	0.89250	6


Proposed Route : (Option 01) – Tram Line in Both Direction
OPTION 01
Howrah District
Kolkata District
Source : Author generated
LEGEND -
Top 50 Heritage Sites
1-10
11-20
21-30
31-40
41-50
Proposed Tram Route (Top 50)
OPTION 1
Roads
Railways
KMC_Landuse
Residential
Commercial
Public Semi Public
Industrial
Mixed Use
Recreational
City Forest/ Grass
Military
KMC_Waterbody
KMC Boundary
New Tram Line
Existing Tram Line
Metro line
Population Density
less than 14617
14617 - 19364
19364 - 23393
23393 - 28111
28111 - 36258
36258 - 45169
45169 - 56615
56615 - 77239
77239 - 123900
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Suitable ROW (Range) : (12m - 36m)
% of ROW Use : (17 – 42) %
Land Use : Majorly Mixed Use, Residential and Recreational
Route Length : 10 Km
% of route along Metro Corridor : 33%
Existing Tram Line (Km) : 5.6
New Tram Line (Km) : 4.4
Heritage Site Coverage (Close Proximity)(500mts. Walking Distance) : 23
Avoiding Flyover & Major Junction : Flyover : 0 Major Junction : 2
Proposed Route : (Option 02) - Tram Line in Both Direction
OPTION 2
Suitable ROW (Range) : (15m - 32m)
% of ROW Use : (14 – 33) %
Land Use : Majorly Residential, Commercial and Recreational
Route Length : 14.8 Km
% of route along Metro Corridor : 32%
Existing Tram Line (Km) : 8.2
New Tram Line (Km) : 6.6
Heritage Site Coverage (Close Proximity)(500mts. Walking Distance) : 22
Avoiding Flyover & Major Junction : Flyover : 2 Major Junction : 3
08
RITAM SAMANTA
2022MTPLM008
M.PLAN THESIS
2023-24
Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping
(A Case of Kolkata)
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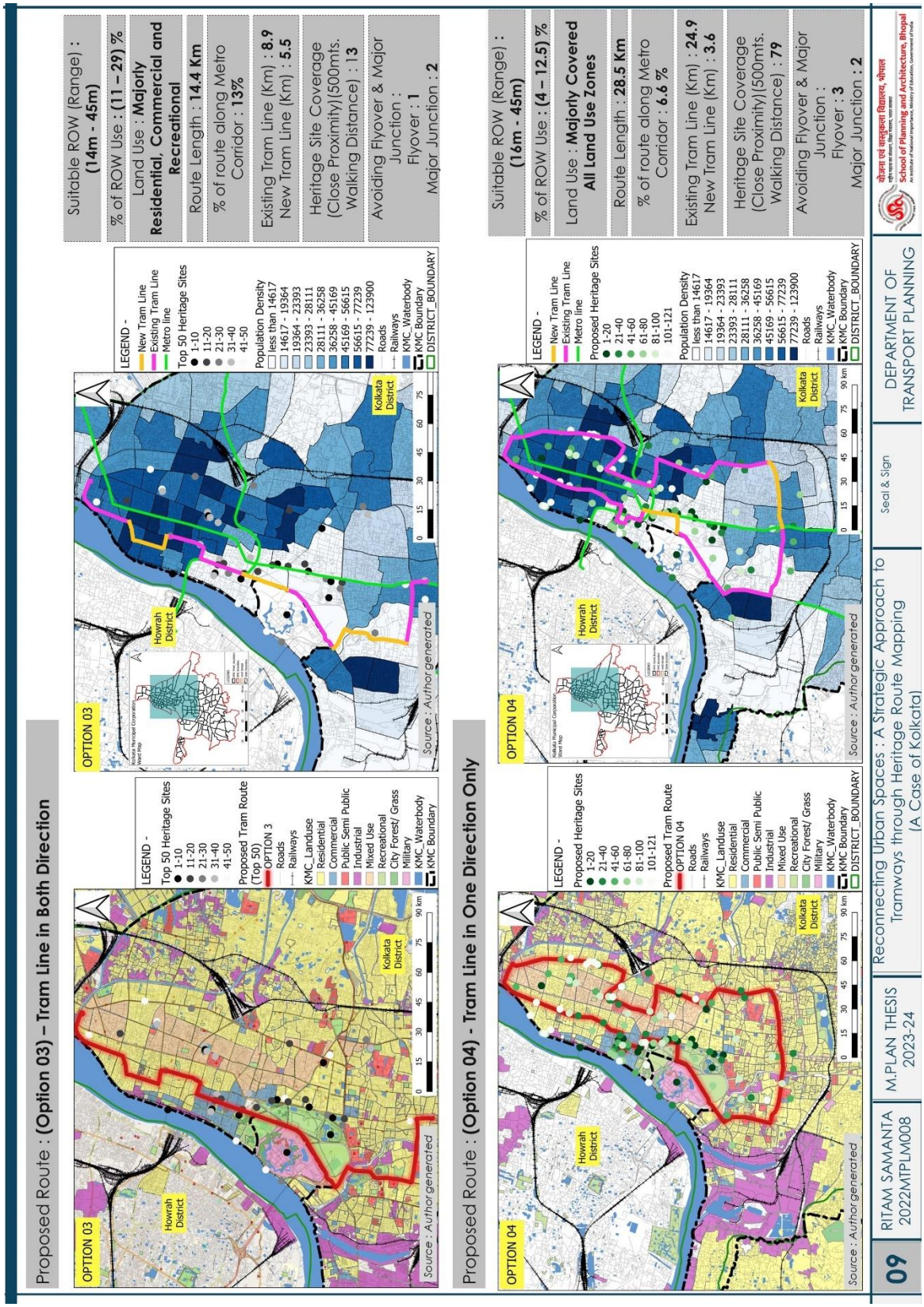
Proposed Route : (Option 03) – Tram Line in Both Direction
OPTION 03
Howrah District
Kolkata District
Source : Author generated
LEGEND -
Top 50 Heritage Sites
1-10
11-20
21-30
31-40
41-50
Proposed Tram Route (Top 50)
OPTION 3
Roads
Railways
KMC_Landuse
Residential
Commercial
Public Semi Public
Industrial
Mixed Use
Recreational
City Forest/ Grass
Military
KMC_Waterbody
KMC Boundary
LEGEND -
New Tram Line
Existing Tram Line
Metro line
Top 50 Heritage Sites
1-10
11-20
21-30
31-40
41-50
Population Density
less than 14617
14617 - 19364
19364 - 23393
23393 - 28111
28111 - 36258
36258 - 45169
45169 - 56615
56615 - 77239
77239 - 123900
Roads
Railways
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Suitable ROW (Range) : (14m - 45m)
% of ROW Use : (11 – 29) %
Land Use : Majorly Residential, Commercial and Recreational
Route Length : 14.4 Km
% of route along Metro Corridor : 13%
Existing Tram Line (Km) : 8.9
New Tram Line (Km) : 5.5
Heritage Site Coverage (Close Proximity)(500mts. Walking Distance) : 13
Avoiding Flyover & Major Junction :
Flyover : 1
Major Junction : 2
Proposed Route : (Option 04) - Tram Line in One Direction Only
OPTION 04
Howrah District
Kolkata District
Source : Author generated
LEGEND -
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Proposed Tram Route
OPTION 04
Roads
Railways
KMC_Landuse
Residential
Commercial
Public Semi Public
Industrial
Mixed Use
Recreational
City Forest/ Grass
Military
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
LEGEND -
New Tram Line
Existing Tram Line
Metro line
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Population Density
less than 14617
14617 - 19364
19364 - 23393
23393 - 28111
28111 - 36258
36258 - 45169
45169 - 56615
56615 - 77239
77239 - 123900
Roads
Railways
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Suitable ROW (Range) : (16m - 45m)
% of ROW Use : (4 – 12.5) %
Land Use : Majorly Covered All Land Use Zones
Route Length : 28.5 Km
% of route along Metro Corridor : 6.6 %
Existing Tram Line (Km) : 24.9
New Tram Line (Km) : 3.6
Heritage Site Coverage (Close Proximity)(500mts. Walking Distance) : 79
Avoiding Flyover & Major Junction :
Flyover : 3
Major Junction : 2
09
RITAM SAMANTA
2022MTPLM008
M.PLAN THESIS
2023-24
Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping
(A Case of Kolkata)
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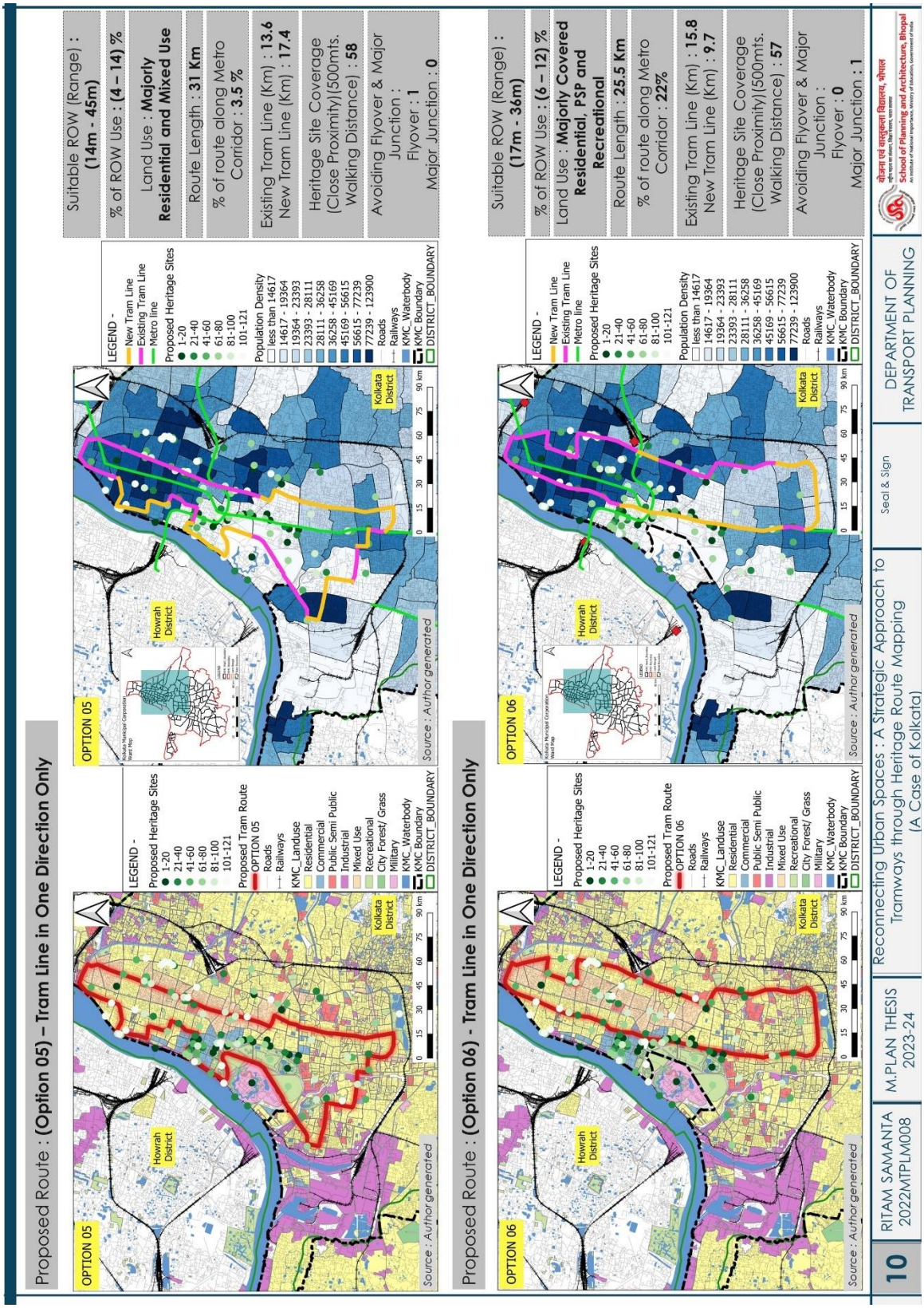
Proposed Route : (Option 05) – Tram Line in One Direction Only
OPTION 05
Howrah District
Kolkata District
Source : Author generated
LEGEND -
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Proposed Tram Route
OPTION 05
Roads
Railways
KMC_Landuse
Residential
Commercial
Public Semi Public
Industrial
Mixed Use
Recreational
City Forest/ Grass
Military
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Suitable ROW (Range) : (14m - 45m)
% of ROW Use : (4 – 14) %
Land Use : Majorly Residential and Mixed Use
Route Length : 31 Km
% of route along Metro Corridor : 3.5 %
Existing Tram Line (Km) : 13.6
New Tram Line (Km) : 17.4
Heritage Site Coverage (Close Proximity)(500mts. Walking Distance) : 58
Avoiding Flyover & Major Junction : Flyover : 1 Major Junction : 0
OPTION 05
Howrah District
Kolkata District
Source : Author generated
LEGEND -
New Tram Line
Existing Tram Line
Metro line
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Population Density
less than 14617
14617 - 19364
19364 - 23393
23393 - 28111
28111 - 36258
36258 - 45169
45169 - 56615
56615 - 77239
77239 - 123900
Roads
Railways
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Proposed Route : (Option 06) - Tram Line in One Direction Only
OPTION 06
Howrah District
Kolkata District
Source : Author generated
LEGEND -
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Proposed Tram Route
OPTION 06
Roads
Railways
KMC_Landuse
Residential
Commercial
Public Semi Public
Industrial
Mixed Use
Recreational
City Forest/ Grass
Military
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Suitable ROW (Range) : (17m - 36m)
% of ROW Use : (6 – 12) %
Land Use : Majorly Covered Residential, PSP and Recreational
Route Length : 25.5 Km
% of route along Metro Corridor : 22%
Existing Tram Line (Km) : 15.8
New Tram Line (Km) : 9.7
Heritage Site Coverage (Close Proximity)(500mts. Walking Distance) : 57
Avoiding Flyover & Major Junction : Flyover : 0 Major Junction : 1
OPTION 06
Howrah District
Kolkata District
Source : Author generated
LEGEND -
New Tram Line
Existing Tram Line
Metro line
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Population Density
less than 14617
14617 - 19364
19364 - 23393
23393 - 28111
28111 - 36258
36258 - 45169
45169 - 56615
56615 - 77239
77239 - 123900
Roads
Railways
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
10
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2022MTPLM008
M.PLAN THESIS
2023-24
Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping
(A Case of Kolkata)
Seal & Sign
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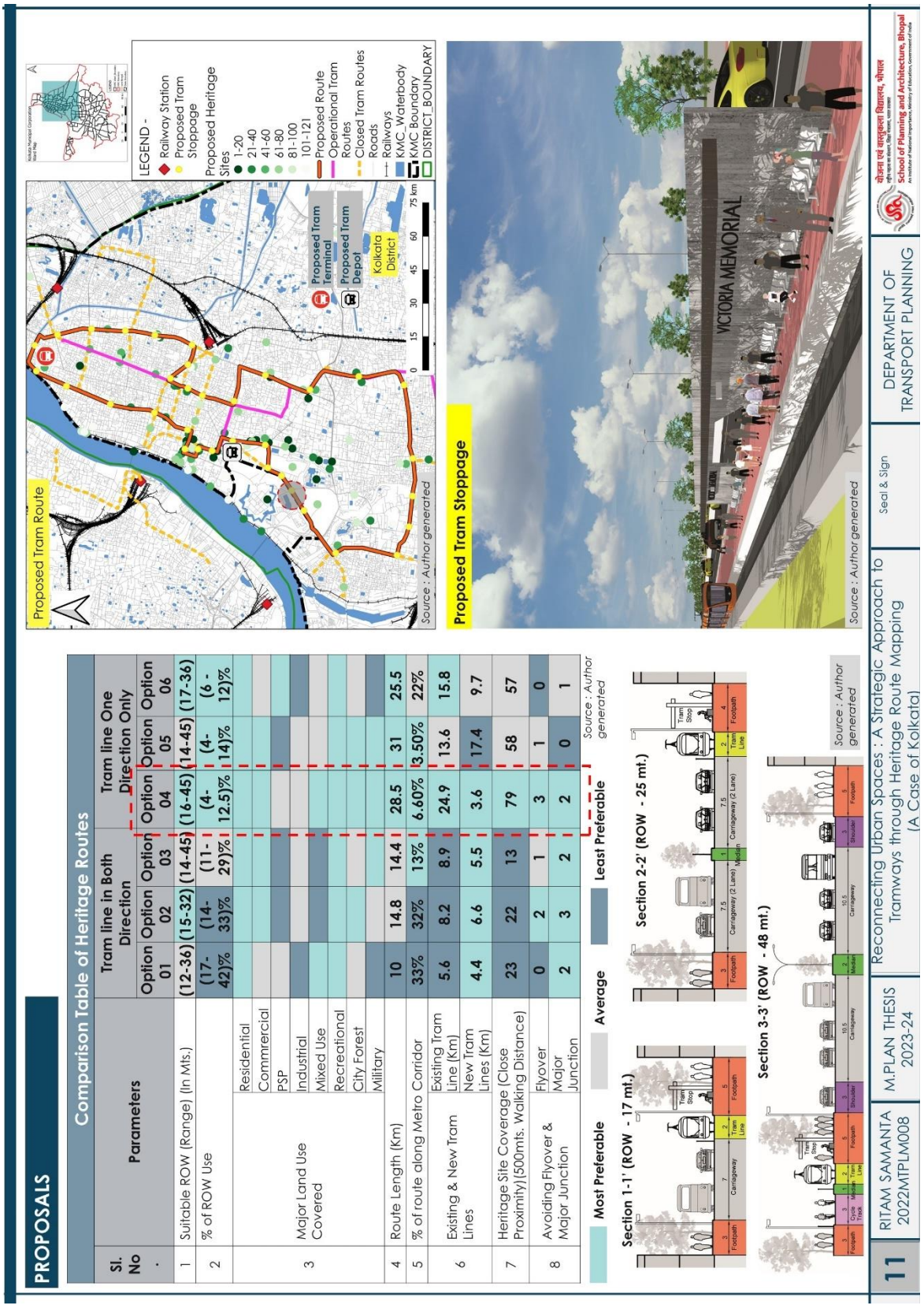
PROPOSALS
Comparison Table of Heritage Routes
Sl. No.
Parameters
Tram line in Both Direction
Tram line One Direction Only
Option 01
Option 02
Option 03
Option 04
Option 05
Option 06
1 Suitable ROW (Range) (In Mts.) (12-36) (15-32) (14-45) (16-45) (14-45) (17-36)
2 % of ROW Use (17-42)% (14-33)% (11-29)% (4-12.5)% (4-14)% (6 - 12)%
3 Major Land Use Covered
Residential
Commercial
PSP
Industrial
Mixed Use
Recreational
City Forest
Military
4 Route Length (Km) 10 14.8 14.4 28.5 31 25.5
5 % of route along Metro Corridor 33% 32% 13% 6.60% 3.50% 22%
6 Existing & New Tram Lines
Existing Tram Line (Km) 5.6 8.2 8.9 24.9 13.6 15.8
New Tram Lines (Km) 4.4 6.6 5.5 3.6 17.4 9.7
7 Heritage Site Coverage (Close Proximity) (500mts. Walking Distance) 23 22 13 79 58 57
8 Avoiding Flyover & Major Junction
Flyover 0 2 1 3 1 0
Major Junction 2 3 2 2 0 1
Most Preferable
Average
Least Preferable
Source : Author generated
Section 1-1' (ROW - 17 mt.)
Section 2-2' (ROW - 25 mt.)
Section 3-3' (ROW - 48 mt.)
Source : Author generated
Proposed Tram Route
LEGEND -
Railway Station
Proposed Tram Stoppage
Proposed Heritage Sites
1-20
21-40
41-60
61-80
81-100
101-121
Proposed Route
Operational Tram Routes
Closed Tram Routes
Roads
Railways
KMC_Waterbody
KMC Boundary
DISTRICT_BOUNDARY
Proposed Tram Terminal
Proposed Tram Depot
Kolkata District
Source : Author generated
Proposed Tram Stoppage
VICTORIA MEMORIAL
Source : Author generated
11
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2023-24
Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping
(A Case of Kolkata)
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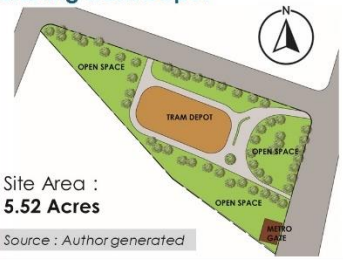
Proposed Tram Routes

Proposed Tram Route							
Length (KM)	Tram Stops	Layover Time (Min.)	Total Halt Time (MIn.)	Running Time (Min.)	Journey Time (Min.)	Min. Calculated Headway (Min.)	Proposed Headway (Min.)
28.5	**35**	**10**	**15**	**85**	**100**	**10**	**15**

Source : Author generated

Tram Depot Modification

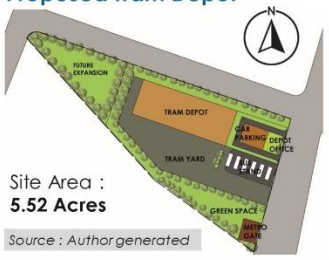
Existing Tram Depot



Site Area :
5.52 Acres

Source : Author generated

Proposed Tram Depot



Site Area :
5.52 Acres

Source : Author generated

Proposed View of Tram Depot

Source : Author generated

Proposed View of Parking Area

Source : Author generated

RECOMMENDATIONS

Financial Aspects

Govt Funds

Atal Mission for Rejuvenation and Urban Transformation

SUTP Sustainable Urban Transport Project (India)

Global Funds

ADB ASIAN DEVELOPMENT BANK

IFC International Finance Corporation WORLD BANK GROUP

Planning Aspects

In Kolkata's context, **CAF Urbos models and Citadis X02 (Second generation)** models can be used, the base price for a single Citadis tram unit ranged from approximately €2 million to €4 million (17 – 33 crore Indian rupees),

Technical Aspects

Route Termination & Remapping of Bus Routes–
Traffic congestion in peak hours are some of the regular instances that Kolkata is facing.

Increase in Parking Charge –
In different phases of the routes, cars are parked on street, blocking existing Tram lanes.

PARKING

12	RITAM SAMANTA 2022MTPLM008	M.PLAN THESIS 2023-24	Reconnecting Urban Spaces : A Strategic Approach to Tramways through Heritage Route Mapping (A Case of Kolkata)	Seal & Sign	DEPARTMENT OF TRANSPORT PLANNING	योजना एवं वास्तुकला विद्यालय, भोपाल School of Planning and Architecture, Bhopal

Annexure VI – Plagiarism Report

Submission date: 01-May-2024 11:42PM (UTC+0530)
Submission ID: 2368029502
File name: 2022MTPLM008.pdf (12.77M)
Word count: 23863
Character count: 133106

2022MTPLM008.pdf

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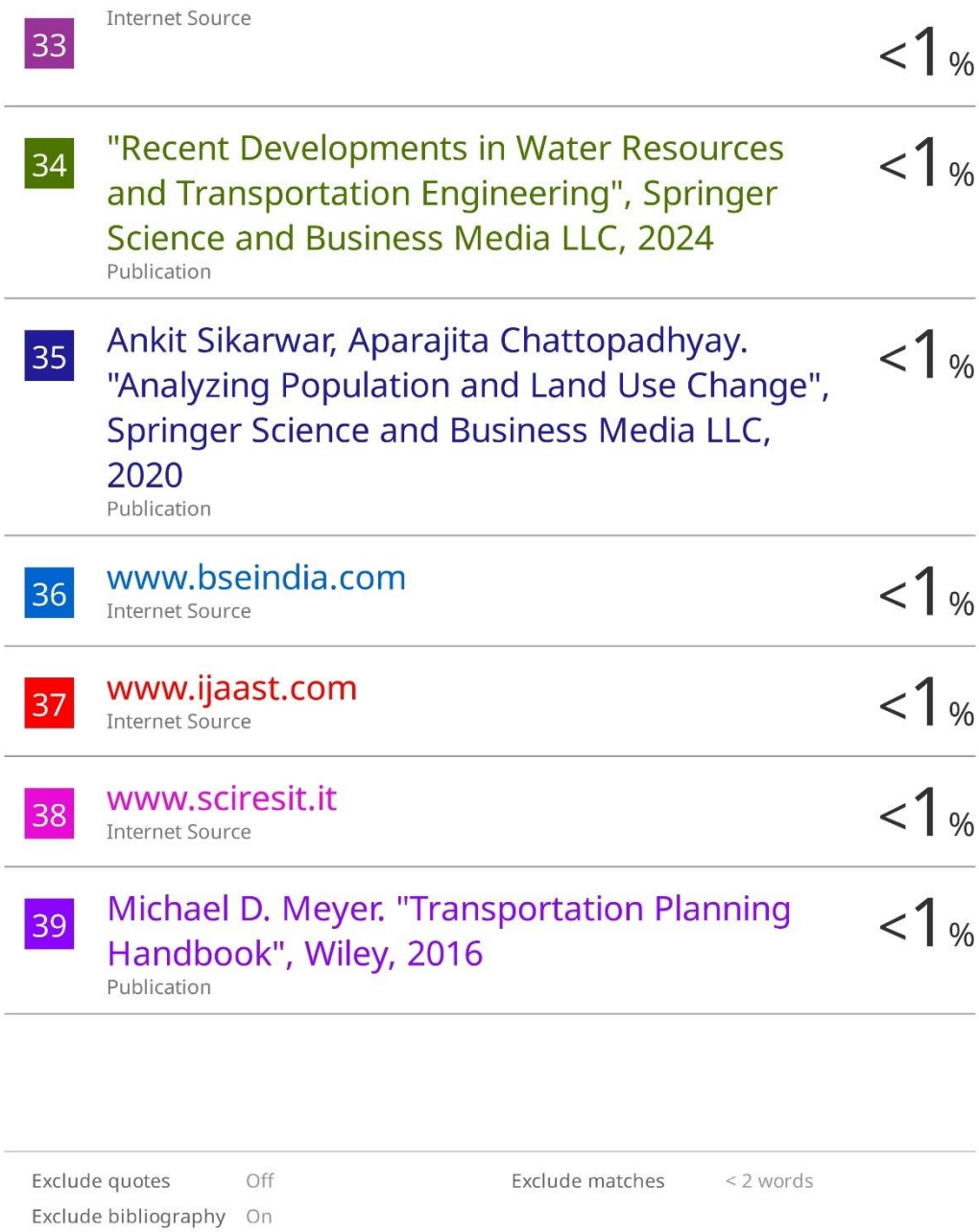

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