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Mass Rapid Transit System at Targhar Station

Amarpreet Kaur, Dnyanesh D Mulik, Sumit M Maurya

Lecturer, Department of Civil Engineering, Agnel Polytechnic, Vashi, Navi Mumbai, Maharashtra, India.
Student, Department of Civil Engineering, Agnel Polytechnic, Vashi, Navi Mumbai, Maharashtra, India.
Student, Department of Civil Engineering, Agnel Polytechnic, Vashi, Navi Mumbai, Maharashtra, India.

ABSTRACT: The paper focuses on integrating multiple transit systems Bus Depot, Railway Station, Metro Station, and Roadways at Targhar in Navi Mumbai to develop a sustainable, efficient, and accessible Mass Rapid Transit (MRT) hub. With the ongoing Navi Mumbai International Airport nearby, Targhar is expected to become a vital transport node. The proposed design ensures smooth connectivity between various modes of transport, reducing traffic congestion and travel time. Key features include dedicated ramps, loop connections, link roads, EV buses, and smart infrastructure materials to support eco-friendly development. The integration of AI- based traffic management and piezoelectric pavements aims to enhance operational efficiency and sustainability. An integrated ticketing system is also proposed to save cost and time for commuters. The paper aims to improve last-mile connectivity, reduce carbon emissions, and boost the overall urban transport network. This multi-modal integration will support economic growth, reduce vehicular load, and provide a modern transit experience to the citizens.

KEY WORDS: Intermodal Connection, Mass rapid Transit, Bus rapid Transit, Traffic management, Smart and sustainable infrastructure

I. INTRODUCTION

The Navi Mumbai International Airport (NMIA) started commercial operations on December 25, 2025. The airport is set to handle 20 million passengers annually in its initial phase, with plans to increase capacity to 90 million upon completion of all phases. Integrating transit systems at Targhar is crucial because this node is poised to become a major inter-modal hub in Navi Mumbai as Targhar is set to serve as the railway connection point linking conventional suburban trains with upcoming metro services.

Mass Rapid Transit System (MRTS) refers to high-capacity, efficient, and reliable urban public transportation networks designed to move large numbers of people quickly and efficiently within metropolitan areas. MRTS systems help reduce traffic congestion, lower pollution levels, and improve urban mobility. Mass rapid transit (MRT) refers to public transportation systems designed to carry large numbers of passengers quickly and efficiently within urban areas. The history of MRT can be traced through several key developments: Early Beginnings 19th Century: The first mass transit systems were horse-drawn carriages and trams. The London Underground, which opened in 1863, is often considered the first subway system in the world. This pioneering system used steam-powered trains and laid the foundation for future underground and elevated rail systems.

MRT is designed for high passenger volumes, featuring multiple cars per train and frequent service intervals. It operates on dedicated corridors elevated, underground, or at-grade to minimize road traffic interference. MRT offers faster transit than traditional buses through fewer stops and prioritized routes, utilizing advanced technologies for automation, ticketing, and real-time monitoring, and is often electrically powered, reducing greenhouse gas emissions compared to road transport.

A. Advantages of MRT

1. By moving large numbers of passengers efficiently, MRTS alleviates road traffic.
2. Promotes the use of cleaner energy and reduces dependence on private vehicles.
3. Reduces travel costs and time for commuters.
4. Improves connectivity, boosts commerce, and enhances property values near transit hubs.

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B. Challenges in implementing MRT

1. Requires significant funding for infrastructure development.
2. Obtaining land for tracks and stations can be challenging, especially in dense urban areas. Long-term maintenance of tracks, stations, and rolling stock can be expensive.
3. Ensuring smooth connectivity with other transportation systems is crucial for efficiency.

Types of transit system

1. Rail-Based Transit Systems
2. Bus-Based Transit Systems
3. Road-Based Transit Systems
4. Cable-Based Transit Systems
5. Emerging and Hybrid Systems

SATIS (Station Area Traffic Improvement Scheme):

The Station Area Traffic Improvement Scheme (SATIS) is an urban infrastructure initiative designed to address the challenges of traffic congestion, poor pedestrian movement, and chaotic transit conditions around railway stations and other transit hubs. These areas often experience heavy footfall and vehicular traffic, especially in cities like Mumbai, where railway stations are lifelines for millions of daily commuters. The SATIS project integrates multi-modal traffic planning with infrastructure upgrades to improve accessibility, safety, and the commuter experience. It is implemented by municipal corporations in collaboration with urban development bodies like the Mumbai Metropolitan Region Development Authority (MMRDA) and involves both short-term solutions and long- term infrastructure enhancements..

Example of Thane SATIS:

The SATIS initiative in Mumbai has enhanced urban transport efficiency across several transit hubs. Notable projects include the Thane Railway Station, which features a 2.4-km skywalk, organized transport lanes, and improved signaling, enhancing commuter experience and reducing congestion. The Borivali project targets crowding with pedestrian skywalks and distinct transport zones, while the Kalyan project integrates services and upgrades transport facilities. Overall, these initiatives contribute to better vehicular flow, fewer pedestrian accidents, shorter travel times, and reduced emissions, supporting sustainable transport and urban quality of life amidst rapid urbanization.

II. TARGHAR STATION AREA

Targhar Railway Station in Navi Mumbai's Raigad district serves as a vital transit hub for passengers to the upcoming Navi Mumbai International Airport (NMIA). Part of the Nerul-Uran railway line, it aims to enhance travel efficiency and reduce time. As a multi-modal hub, it integrates various transport forms to facilitate smoother passenger movement. The NMIA development is anticipated to spur population growth around Targhar, promoting economic growth and urbanization due to its strategic access to the airport.

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Current scenario Targhar:

Currently undergoing expansion and transformation, Targhar is becoming an important transit hub in Navi Mumbai's changing transportation system. Targhar is being planned as an intermodal hub that would eventually connect suburban trains with feeder bus services and proposed metro lines, even though construction is still ongoing and nearby stations like Bamandongari and Kharkopar are already operational. Ongoing clover leaf construction in front of the Targhar station connecting airport to the under construction coastal road project taking traffic from Palm beach road and Uran, JNPT that is the NH348A. The coastal road is planned to be a six lane highway starting at Amra Marg in Belapur and
ending at Shivaji Nagar in Ulwe comprising of 5.8km with an direct elevated connection to NMIA of 1.2km.

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Figure 1.Cloverleaf construction at Targhar

Figure 2. Coastal road Construction at Targhar

III. LITERATURE SURVEY

Mass Rapid Transit Systems (MRTS) are passenger transit systems that provide a convenient and efficient way for passengers to travel in urban areas. These systems have a history dating back to the London Underground in 1863, with other cities like Boston, New York City, Madrid, Barcelona, Moscow, and Moscow also having their own systems.
In India, the first MRT was the Kolkata metro in 1984, followed by Delhi and Gurgaon in 2002 and 2013. Five more cities have since started building MRTs, including Mumbai, Hyderabad, Bangalore, Chennai, and Kochi. The need for MRTs has increased due to the rapid growth of India's urban population between 1981-2001, which led to increased traffic congestion and accidents due to an outdated transport system as per Author Kumar Amal Vats.

Airport accessibility is a crucial factor in the utilization of connecting transportation modalities, influenced by factors such as distance, time, and cost. Improved road infrastructure near airports has improved public transportation services, offering passengers more convenience and speed in reaching them. This research aims to develop scientific perspectives on public transport integration system (PTIS) implementation and advocate for public transport operators' inclusion in integrated transportation services. The expected outcomes include reduced waiting times, congestion alleviation, improved air quality, enhanced safety, and enhanced passenger comfort as per Authors Danny Setiawan, SigitPriyanto, Mukhammad Rizka Fahmi Amrozi.

Various codes which are used for the project IRC 73:1980, IRC 66:1976, IRC SP:23, IRC 92:1985, IRC 87:1984, AASHTO Green Book, IRC 5:2015, IRC SP:41-1994, IRC 99:2018, IRC 106:1990, AASHTO Roadside Design Guide, AASHTO Standard Specifications for Highway Bridges.

IV. SCOPE OF THE PAPER

A. Impact of MRT on Targhar

As of April 2025, Targhar remains without operational Metro service, with Line 1 terminating at Pendhar. The Targhar Railway Station is under construction, leaving no current metro access. However, anticipation of future MRT integration has stimulated local real estate demand, seeing average apartment rates at ₹11,832 per sq ft. Concurrent infrastructure projects, like the Ulwe Coastal Road and MTHL-airport corridors, are enhancing connectivity and driving economic activity in the region. With the ongoing expansion of Navi Mumbai Metro, real estate prices are expected to increase further. Major initiatives like the Mumbai Trans Harbour Link have

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already prompted an 8-10% rise in nearby property values, affecting Targhar's market positively as infrastructure development leads to improved connectivity and urban growth.

The project aims to improve the efficiency of traffic management and reduce congestion by introducing a new integrated transit system. It focuses on connecting various modes of transport buses, trains, metro, and private vehicles for a seamless travel experience. The plan includes integrating a bus transit system to handle high passenger volumes and designing link roads to ensure smooth traffic flow between key areas such as Belapur and Panvel. Additionally, it proposes an integrated ticketing system to save time and money for commuters, while enhancing the utilization of the Atal Setu. To promote sustainability, the project envisions deploying electric buses to lower carbon emissions and using smart infrastructure materials for building durable and eco-friendly stations and depots. Finally, it emphasizes improving last-mile connectivity to provide a convenient and efficient end-to-end travel experience.

B. Key Traffic Improvement Projects Near Targhar:

1. Kharghar-Turbhe Link Road (KTLR) Project Objective:
To alleviate traffic congestion on the Sion-Panvel Highway, a 5.49 km road will connect Kharghar and Turbhe, starting near Juinagar Railway Station and ending at the junction near Central Park and Gurudwara. Key features include a 1.763 km twin-tunnel section and a 3.4 km elevated viaduct with 4+4 lanes. The estimated cost is ₹2,100–2,195 crore, with completion expected in 3–4 years. Benefits include a 30-minute reduction in travel time, improved connectivity within the Mumbai Metropolitan Region, and enhanced traffic flow between major hubs like Vashi, Juinagar, and Nerul.

2. Widening and Upgradation of Bhimashankar-Taleghar-Wada-Rajgurunagar Road
To enhance the road infrastructure in Pune district to improve connectivity between Bhimashankar, Taleghar, Wada, and Rajgurunagar. The project involves widening and upgrading to a 2-Lane per Direction (2LPD) configuration. Estimated cost is ₹760.51 crore, with a completion target of 24 months. Expected benefits include improved road safety, enhanced transportation efficiency, and regional economic development.

3. Targhar Railway Station Developments
While specific traffic improvement projects directly at Targhar Railway Station are not detailed in the available sources, the ongoing infrastructure developments in the surrounding areas, such as the Kharghar-Turbhe Link Road, are expected to enhance overall connectivity and traffic flow in the region.

4. Broader Traffic Initiatives in Navi Mumbai
The Maharashtra government is implementing several projects in Navi Mumbai to enhance traffic conditions, including the development of signal-free corridors to reduce congestion, the expansion of metro lines for better public transport, and the construction of flyovers and bridges to improve traffic flow.

5. Intermodal Connectivity
i. Targhar Railway Station is under construction within the Nerul-Uran rail corridor, set to feature two platforms and provide crucial links in the suburban railway network. Its proximity to the upcoming Navi Mumbai International Airport increases its importance.
ii. The Mumbai Trans Harbour Link (MTHL) project includes a coastal road with a 1.2 km segment near Targhar, featuring dual elevated corridors for vehicles and a reserved space for future rail connectivity, enhancing integration with the airport.
iii. Developments at Targhar are designed to ensure seamless connectivity to Navi Mumbai International Airport, including a proposed sky train and metro connection to improve urban mobility for travelers.

IV. METHODOLOGY

1. The project methodology was developed by taking reference from the Station Area Traffic Improvement Scheme (SATIS), which is implemented to reduce congestion and improve commuter flow at busy railway stations through elevated decks, FOBs, and segregation of pedestrian and vehicular traffic.

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2. A detailed understanding of SATIS was done to identify how multi-modal integration (bus, auto-rickshaw, pedestrian routes) and dedicated access infrastructure can reduce bottlenecks, improve safety, and provide a better commuter experience.
3. The study began with determining a suitable location for implementation; multiple locations were reviewed, and after feasibility observations, the focus was shifted from highly congested zones like Andheri and already well-managed hubs like Belapur to Targhar in Navi Mumbai.
4. Targhar was finalized due to its expected future pressure from the Navi Mumbai International Airport (NMIA), ongoing regional infrastructure development, and the need for a planned multi-modal hub before congestion becomes severe.
5. A site visit and physical survey were carried out at Targhar station to verify the ground conditions, understand the surrounding development works (coastal road and cloverleaf connections), and identify available land behind the station for planning a BRT–MRT integration hub.
6. Route analysis was conducted to finalize bus movement corridors; two options were studied, including a direct route across mangrove-protected areas and a CIDCO expressway-based route connecting coastal road and NMIA.
7. The expressway-based route was selected as it avoided environmental damage, supported broader regional connectivity (Belapur, Panvel, NH-348A), and enabled planned interchange connections for buses from NMIA and the coastal road.
8. Based on site constraints such as nearby residential development, two one-way interchange connections were planned to reduce congestion probability and to provide safer merging and weaving conditions.
9. A link road was designed to connect the interchange system and the proposed bus hub with CIDCO's proposed road network, allowing smooth bus movement from Belapur and Panvel through NH-348A connectivity.
10. Geometric design calculations were performed for the direct ramp, semi-direct loop, and link road to determine curve radius, stopping sight distance (SSD), superelevation, ramp length, merge taper length, and gradients using IRC provisions and AASHTO references where required.
11. The bus depot was planned in a rectangular layout with reference to IRC 70:2017, designed to accommodate 50 buses at a time, and provisions were included for internal circulation, parking bay dimensions, and operational zoning.
12. Sustainability and smart features were incorporated in the methodology by proposing an EV-only bus depot with charging facilities, along with smart infrastructure applications such as piezoelectric pavements, AI-based signalling/traffic control, self-healing concrete, and integrated ticketing for multi-modal travel.

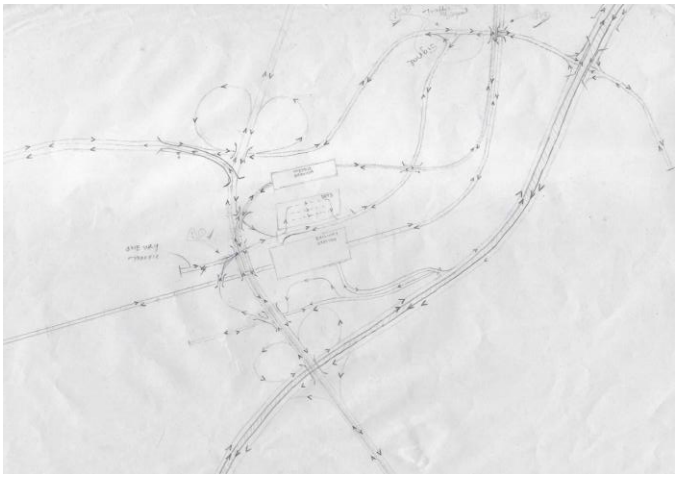

Figure 3. Targhar Station Area Routes

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V. DESIGN RESULTS

1. Direct Connection (Ramp)
The Direct Connection (Ramp) facilitates vehicles changing direction directly, commonly in flyovers or elevated roadways. Key parameters include: Ramp Length (L) of 65.52 meters, Transition Curve Length (Lt) of 9.48 meters for smooth transitions, Circular Curve Length (Lc) of 38.79 meters for maintaining constant curvature, and a Final Ramp Radius (R) of 113.79 – 114 meters for safe turning. The Ramp Gradient (Grade) is 6.19%, well within the comfort threshold, while the Stopping Sight Distance (SSD) is 24.43 meters, indicating lower design speeds for safety.

2. Semi-Direct Connection (Loop)
Semi-Direct Connection (Loop) involves a loop ramp, ideal for constrained spaces. The specifics include a ramp radius of 12.003 meters, which necessitates low speeds due to its sharpness. The ramp length is 200 meters, allowing for smoother transitions despite the tight curvature. A merge taper length of 48 meters facilitates safe acceleration or deceleration for merging traffic. The stopping sight distance is 127.59 meters, indicating the design accommodates higher reaction distances or speeds than a direct ramp.

3. Link Road
This road segment serves as a transitional connection for traffic movement, featuring a total width of 10 meters ensuring safety and comfort by accommodating one or more lanes and shoulders. It has a minimum horizontal curve radius of 27.99 meters, suitable for urban or interurban settings. The stopping sight distance is set at 47.24 meters, designed for urban driving conditions. Additionally, a super-elevation of 7% is provided on curves to enhance vehicle stability and comfort.

Feature	Direct Ramp	Semi-Direct Loop	Link Road
Radius (R)	~114 m	12.003 m	27.99 m
Ramp/Road Length (L)	65.52 m	200 m	–
SSD	24.43 m	127.59 m	47.24 m
Super-Elevation (e)	–	–	7%
Gradient	6.19%	–	–

Table 1. Design Results

VI. CONCLUSION AND FUTURE WORK

This project on integrating a Bus Depot, Railway Station, Metro Station and roadway-based MRT system at Targhar demonstrates how a planned multimodal transit hub can transform Targhar into a high-efficiency and sustainable transport node in Navi Mumbai. The proposed layout focuses on smooth vehicle transitions with reduced weaving conflicts, which helps reduce travel time and manage peak-hour congestion more effectively. The integration of BRT feeder services, an integrated ticketing system, and smart/sustainable infrastructure supports seamless transfers between suburban rails, metro, buses and private vehicles, while also improving last-mile connectivity and reducing carbon emissions through EV-based operations. The report also highlights wider benefits such as transit-oriented development around the station, improved commerce and employment, and a scalable framework for future expansions like an airport link and further metro phases as NMIA demand rises.

- Prepare detailed cost estimation and financial feasibility (CAPEX, OPEX, revenue sources, PPP possibilities) for the complete hub and interchange system.
- Develop implementation phasing and construction planning to execute the project in stages with minimum disruption and clear milestones.
- Carry out stakeholder mapping and coordination planning (CIDCO, railways, traffic police, bus operators, metro authority, and local bodies) for approvals and operations.

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- Perform detailed risk assessment and maintenance planning, including lifecycle maintenance strategy for ramps, pavements, depot, and smart systems.
- Add more technical drawings/visual aids (detailed layout plans, sections, traffic circulation plans, signage/marking plans) for clearer execution-level understanding.
- Plan and detail future expansions such as sky-train/airport connectivity, additional metro phases, and SATIS-type station area upgrades to preempt congestion after NMIA starts operations.

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AUTHOR'S BIOGRAPHY

Full Name	**Amarpreet Kaur**
Degree	M-Tech (Construction Management)
Institution	Agnel Polytechnic, Vashi, Navi Mumbai
Designation	Lecturer

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Full Name	Dnyanesh Dhondiram Mulik
Degree	Diploma (Civil)
Institution	Agnel Polytechnic, Vashi, Navi Mumbai
Academic Profession	Student

Full Name	Sumit Mahadeo Maurya
Degree	Diploma (Civil)
Institution	Agnel Polytechnic, Vashi, Navi Mumbai
Academic Profession	Student