CHAPTER 117

Revolutionizing Urban Transit:
A Comprehensive Look at Metro Rail Projects in India

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ABSTRACT

India's urbanization has increased need for sustainable and effective public transit systems. Projects including metro rail have become an essential way to reduce traffic, improve connectivity, and stimulate economic expansion. With an emphasis on funding strategies including Public-Private Partnerships (PPP), Land Value Capture (LVC), and Additional Development Rights (ADR), this paper examines the development of metro rail in India. The integration of various financial models and their effects on urban growth are examined using the Hyderabad Metro as a case study. In order to determine if international metro finance techniques, such as those used by the Tokyo Metro and Hong Kong MTR—are applicable in India, the research examines them. The financial structure, income generation, zoning laws, and real estate effect of the Hyderabad Metro, the biggest PPP metro project in India, are all addressed. The results show that property prices are greatly impacted by metro construction, with significant appreciation occurring in communities along the metro lines. The financial viability of metro expansions has also been aided by the adoption of FAR-based zoning laws and transit-oriented development (TOD). In order to guarantee that metro projects continue to be financially viable, this study highlights the necessity of finding new income streams outside of fares. India's metro networks may expand more effectively with the use of value capture techniques and astute urban planning. In order to enhance metro finance through equitable and sustainable financial models, the study provides stakeholders, planners, and legislators with useful insights.

Keywords: Land development mechanism; Value capture mechanism; Additional Development Rights (ADR); Mass rapid transport; Influence zone.


1.0 Introduction

Background: India's fast urbanization has made transportation extremely difficult, necessitating the development of sustainable and effective transit systems.

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Metro rail systems are now crucial for lowering traffic, increasing connection, and speeding up travel. The Delhi Metro's performance since 2002 established the norm for contemporary metro systems, while India's first metro, the Kolkata Metro, began operations in 1984. Since then, other cities have created their own metro systems, including Ahmedabad, Hyderabad, Bengaluru, Mumbai, Chennai, Jaipur, Lucknow, and Kochi see (Figure 1). In order to facilitate metro construction, the government's 2017 Metro Rail Policy encourages financing techniques including Value Capture Finance (VCF), Public-Private Partnerships (PPP), and sustainable finance models. The metro systems in each city are made to fit local requirements; for instance, Bengaluru's Namma Metro helps reduce traffic in the IT corridor, while Mumbai Metro combines with suburban rail. Even with the metro's quick growth, financing is still difficult. To ensure sustainable metro growth, creative financial techniques including Land Value Capture (LVC), Transit-Oriented growth (TOD), and Additional Development Rights (ADR) are essential.

Figure 1: Operational Metro Rail Lengths in India
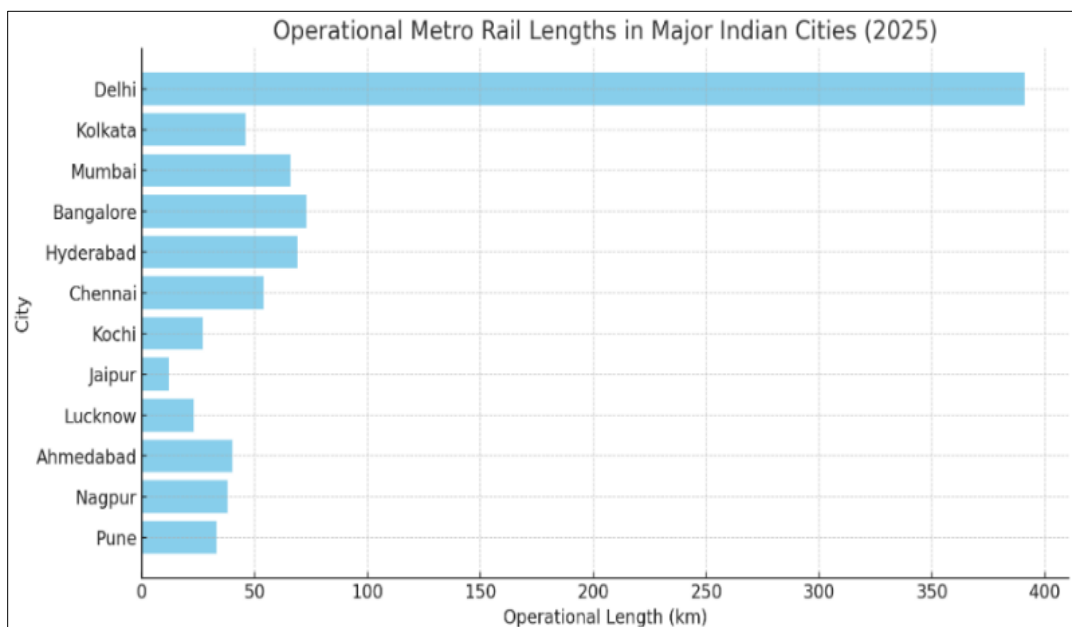
Source: Compiled by authors

The Hyderabad Metro is a state-of-the-art metro system that was constructed in 2010 for $2.2 billion under a PPP model with L&T. It links important city centres across a distance of 69 kilometres. Fares, advertisements, and real estate provide revenue, but poor traffic led to financial problems. ADR and LVC can provide long-term viability.

Table 1: Operational Metro Rail in Hyderabad

Corridor	Route	Length (km)	No. of Stations	Status
Red Line	Miyapur ↔ LB Nagar	29.2	27	Operational
Blue Line	Nagole ↔ Raidurg	27	23	Operational
Green Line	JBS Parade Ground ↔ MG Bus Station	11	9	Operational

Source: Compiled by authors

1.2 Objectives

- Propose ways to generate revenue from the metro's impact area, such as land development and value capture methods, to help finance the metro project.
- Create a predictable cashflow for the metro project financed by value capture mechanism.
- Study of the present financing model of the Hyderabad Metro and Suggest land financing infrastructure model.
- A Detailed study of the Metro's in India.

1.3 Need for study & scope of work

The Public-Private Partnership (PPP)-funded Hyderabad Metro has trouble making enough money for development and long-term upkeep. By charging companies and property owners who profit from metro connections, Land Value Capture (LVC) helps recoup some of the higher land prices close to stations. By making money from land sales, company leases, and property development, this lessens dependency on fare revenue. Additionally, by encouraging mixed-use urban expansion near metro stations, LVC encourages Transit-Oriented Development (TOD). In return for payments, developers can construct outside of zoning restrictions under Additional Development Rights (ADR), which helps finance future expansions. Metro impact zones must be identified, property value appreciation must be evaluated, zoning regulations must be updated, and private and public parties must work together in order to implement LVC. Appropriate monitoring is ensured by an oversight authority. Hyderabad Metro may attain sustainable urban growth, financial stability, and a decreased dependency on passenger fares by combining LVC and PPP.

2.0 Literature Review

Analysis of global financial models is aided by a Systematic Literature Review (SLR) employing the PRISMA approach. Funding strategies are categorized under the TCCM model according to research techniques, financial considerations, theory, and context. LVC and TOD are successfully integrated in a number of metro projects across the world. The Delhi Metro employs a combination of government funds, business income, and foreign loans, whereas the Hong Kong MTR finances itself through real estate development. To encourage expansion, London Crossrail uses a combination of company taxes, commercial loans, and public money.

2.1 ADR & LVC

One important urban financing mechanism under Land Value Capture (LVC) is Additional Development Rights (ADR), which permits developers to construct above the designated limit in exchange for payments. This makes it possible to finance metro developments without depending too much on government assistance (Goyal & Patel, 2015). ADR facilitates high-density building close to metro lines by raising the Floor Area Ratio (FAR), which encourages urban growth and generates income (Sejal, 2015). LVC is widely used to recover land value appreciation from metro projects (Shahara, 2018). Traditional funding sources like fare revenue and subsidies are often insufficient, so tools like impact fees, betterment charges, and land monetization support metro expansion (Goyal & Sejal, 2015). The Jaipur Metro used ADR to cover 60% of costs, raising $403.3 million by selling premium FAR near metro stations (Goyal & Patel, 2015).

## 2.2 Systematic Literature Review (SLR) using "PRISMA"

A systematic literature review (SLR) aids in discovering pertinent research, makes it easier to evaluate chosen studies critically for research quality, and aids in clearly summarizing the results. In order to find, choose, assess, and analyse pertinent papers, the Preferred Reporting Items for Systematic analyse, and Meta-Analysis (PRISMA) framework is used in the first stage of systematic literature review. There were three phases to the process see Figure 2.

3.0 Methodology

This study employs a systematic methodology that integrates literature evaluation, data collecting, and analysis to investigate Land Value Capture (LVC) as a funding option for the Hyderabad Metro. With an emphasis on financial instruments including Additional Development Rights (ADR), tax-based finance, and Public-Private Partnerships (PPP), the study looks at LVC models from metro projects in Hyderabad, Bangalore, and Jaipur. While the TCCM model arranges data according to theory, policy, and financial strategies, a Systematic Literature Review (SLR) aids in identifying important patterns.

In addition to field surveys and expert interviews, data is gathered from government publications, satellite photos, and metro planning documents. While on-site surveys examine traffic patterns and real estate trends, secondary data sources include land use, property prices, and metro corridor maps from GHMC, HMRL, and HMDA. Three important questions are addressed in the study. First, it uses expert interviews and document analysis to establish metro impact zones. Second, it uses data analysis and ground surveys to redraw these zones according to land prices, urban expansion, and traffic effect. Third, by examining global case studies and Hyderabad's urban policies, it investigates how LVC techniques might optimize income for metro projects.

Figure 2: PRISMA Process
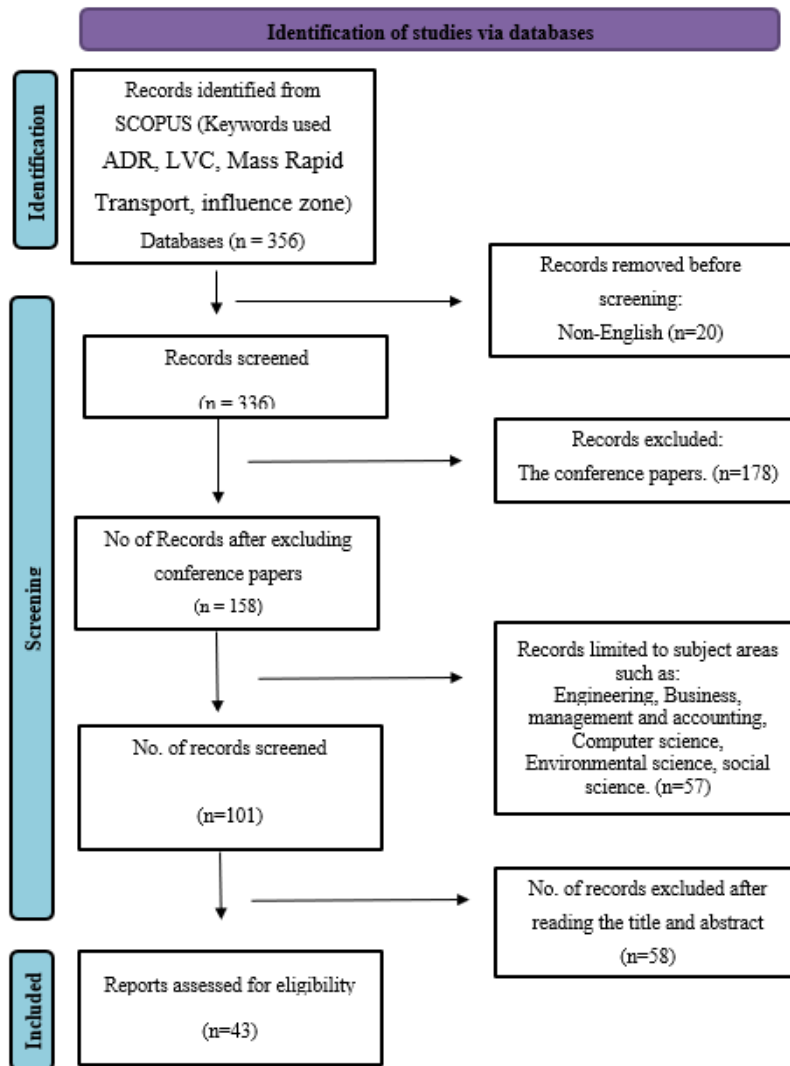
Source: Compiled by authors

4.0 Data Analysis

India's transportation infrastructure is under stress due to the country's fast urbanization, with 600 million people predicted to live in cities by 2031. Increased pollution, lengthier commutes, higher fuel consumption, and traffic congestion are all results of the growing number of private automobile owners. Growing metro rail systems is a long-term way to address these issues.

Figure 3: Methodology
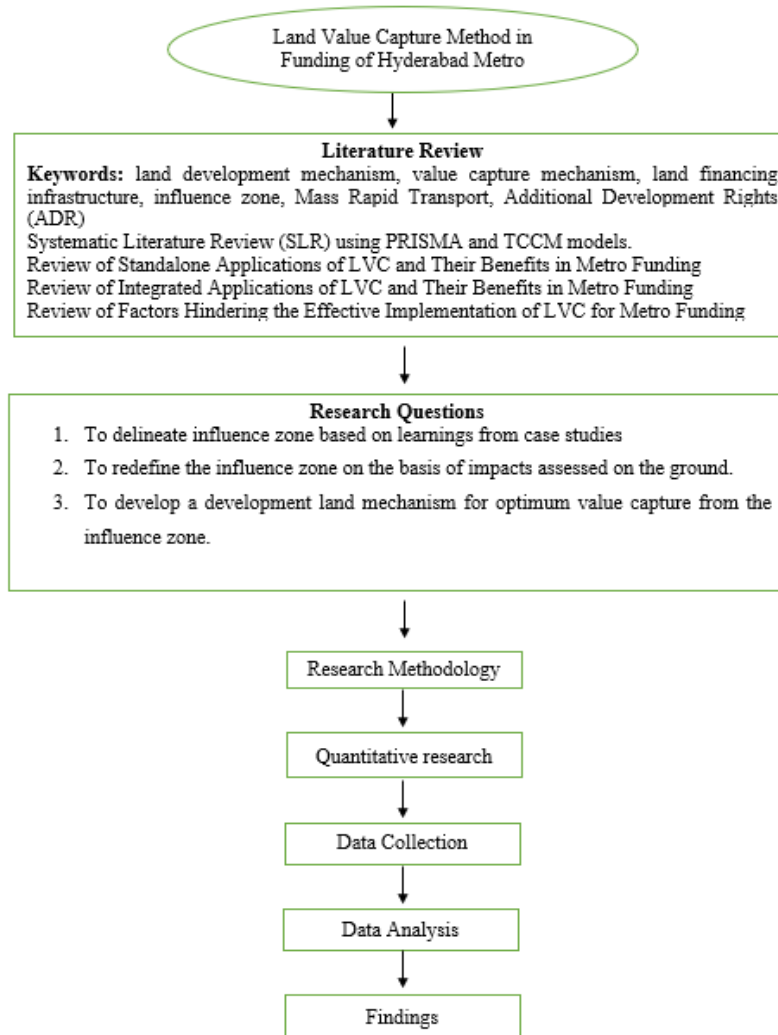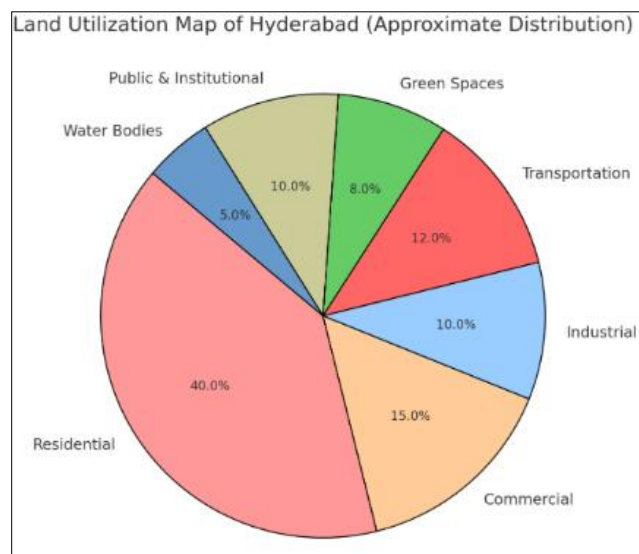

Source: Compiled by authors

Private vehicles and buses are the major forms of transportation in India, which mostly relies on the country's highways. Air pollution, traffic jams, and delays plague major cities including Delhi, Mumbai, Bengaluru, Chennai, and Kolkata. Additionally, many cities lack effective public transportation, which makes people more dependent on their own cars. Traffic congestion, long travel times, bad air quality, and overworked infrastructure are major problems. Metro systems may provide effective, environmentally sustainable urban mobility while reducing traffic, travel time, and pollution. Metro network expansion is essential for better and sustainable urban transportation.

Figure 4: Hyderabad Metro Map
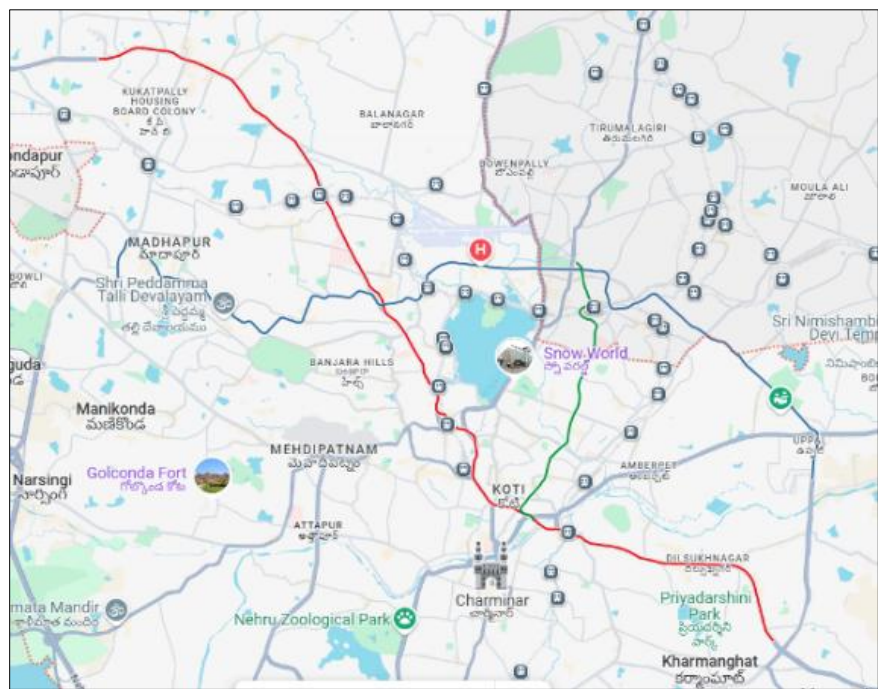
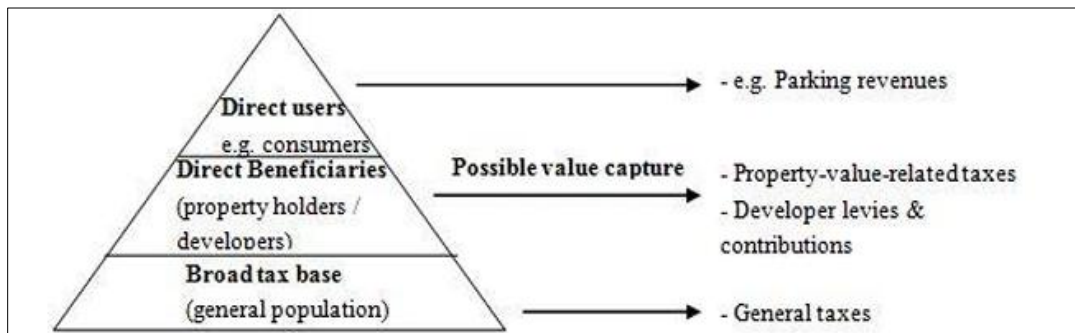**Figure 5: Land Utility Percentage of Hyderabad Metro Influence Zone**
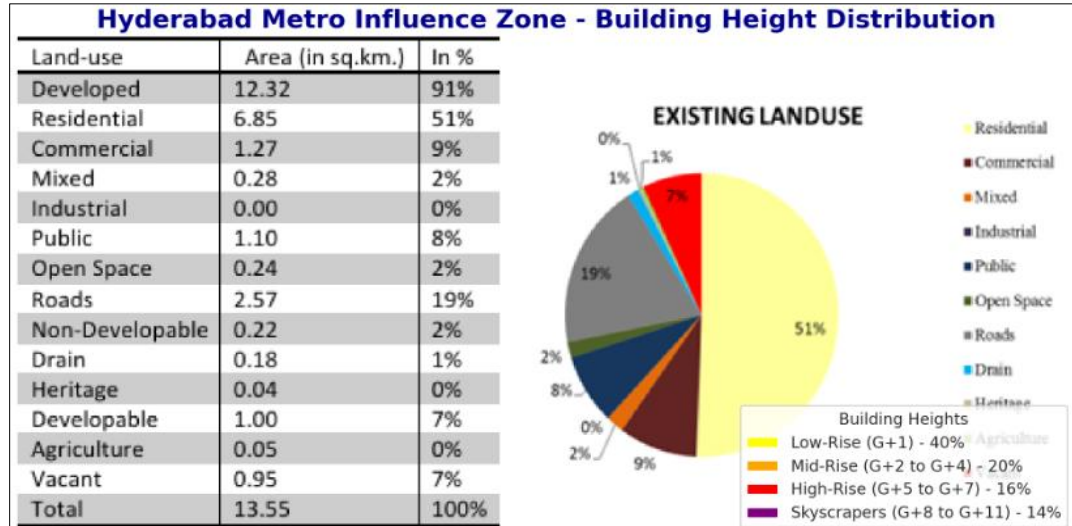
4.1 Funding of Phase 1

In an expanding metropolis of 10 million, the Hyderabad Metro, India's first PPP-based metro, was constructed to cut down on traffic, pollution, and lengthy commutes.

Figure 6: Funding Method

Source: Goyal & Sejal, 2015

Figure 7: Building Height Distribution in Influence Zone

Land-use	Area (in sq.km.)	In %
Developed	12.32	91%
Residential	6.85	51%
Commercial	1.27	9%
Mixed	0.28	2%
Industrial	0.00	0%
Public	1.10	8%
Open Space	0.24	2%
Roads	2.57	19%
Non-Developable	0.22	2%
Drain	0.18	1%
Heritage	0.04	0%
Developable	1.00	7%
Agriculture	0.05	0%
Vacant	0.95	7%
Total	13.55	100%

Source: Author's own creation

The $2.2 billion project, which was created using the DBFOT paradigm, was given to L&T in 2010 with 90% funding and the Telangana government with 10%. Ticket sales, advertisements, real estate, and business ventures around metro stations generated revenue. Non-fare income increased as a result of transit-oriented development, or TOD. The Telangana

government offered financial assistance because of the poor early ridership and cost overruns. Metros in Singapore, Hong Kong, Curitiba, and Delhi are frequently financed by Land Value Capture (LVC), which includes Additional Development Rights (ADR), land taxes, and impact fees. According to studies, ADR can pay for as much as 60% of expenses. To create the finest LVC solutions for long-term finance, Jaipur Metro is examined.

5.0 Analysis and Result

Since 2017, the Hyderabad Metro has fuelled both urban development and increases in property values. The Master Plan 2031 encourages growth that is balanced over 5,965 square kilometres. Metro routes are mostly residential (51%) and commercial (9%), with just 7% of the area suitable for development see figure 7. To effectively handle traffic, environmental issues, and future urban expansion, sustainable planning is required.

Table 2: Property Price Increase in Hyderabad

Table: Property Value Trends in Hyderabad (2017-2024)			
Zone Type	**Locality**	**Growth (%)**	**Key Growth Factors**
High-Growth Residential	Madhapur	91.90%	IT Hub, Business Expansion
	Kondapur	85.70%	Metro Connectivity, IT Sector
	Hitech City	67.30%	Tech Parks, Commercial Growth
	Jubilee Hills	58.80%	High-End Residential Demand
	Gachibowli	48.70%	IT Offices, SEZs
Moderate Growth Residential Zones	Kukatpally	60%	Affordable Housing, Metro Expansion
	Miyapur	55%	Residential Migration
	LB Nagar	52%	Affordable Housing Growth
	Nagole	47%	New Metro Development
High-Growth Commercial	Hitech City	70%	SEZs, IT Companies
	Kukatpally	68.40%	Retail, shopping malls
	Begumpet	82.60%	Business & Transit Hub
	Banjara Hills	62.50%	Luxury Real Estate

Source: Author's own creation

6.0 Practical Implementation

To investigate land usage, property prices, and development potential, the Hyderabad Metro line is separated into prototype zones. Each zone, which has a maximum width of 800 meters, includes important regions surrounding metro stations. These zones are usually between 500 and 1,500 meters in size see figure 8, 9, 10. depending on the distance between metro stations. Each zone is named after the closest metro station to make identification easier. This zoning strategy aids in land use optimization, urban development planning, and evaluating the metro's effects on property values and future growth.

Figure 8: Zoning Area for Red Line   **Figure 9: Zoning Area for Green Line**

Source: Author's own creation & Google Maps

**Figure 10: Zoning Area for Blue Line**

Source: Author's own creation & Google Maps

6.1 Building by laws & FAR regulations in Hyderabad metro influence zone

To control urban growth, the Hyderabad Metro Influence Zone adheres to the Betterment Levy and established Floor Area Ratio (FAR) norms. The standard FAR is 1.5 for group homes, flats, and commercial sites larger than 750 square meters, whereas the premium FAR is up to 2.5. Depending on the width of the road, additional FAR is permitted; for 24 m roads see figure 11, this is 0.5 FAR (30% levy), whereas for 60 m+ roads, it is infinite (50% levy). Institutional plots (more than 500 square meters) exhibit the similar trend. Road width is a

major factor in establishing FAR eligibility; no additional FAR is awarded for roads shorter than 24 meters, but it rises as road width grows. Increased land prices and DLC rates encourage developers to invest in additional FAR, particularly in Hitech City and Raidurg.

Figure 11: Visual Representation of Premium FAR
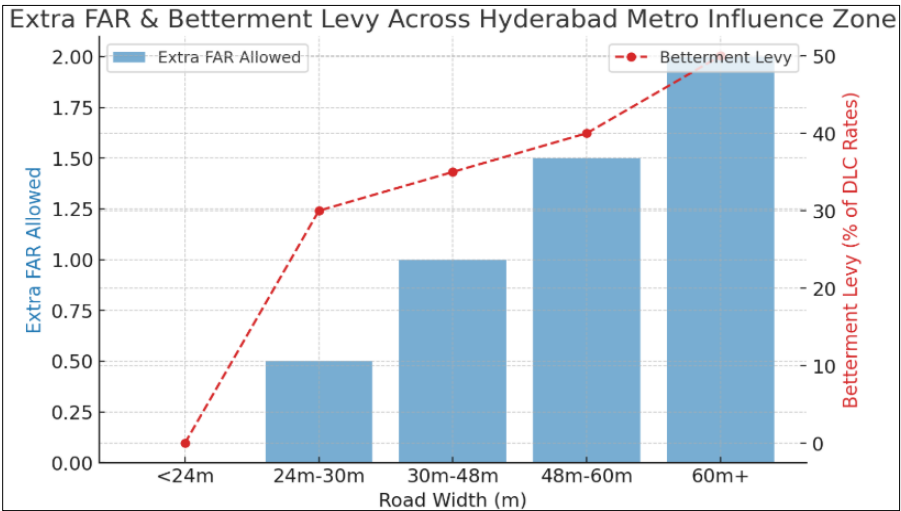
Source: Author's own creation

Figure 12: Revenue Estimation for LVC
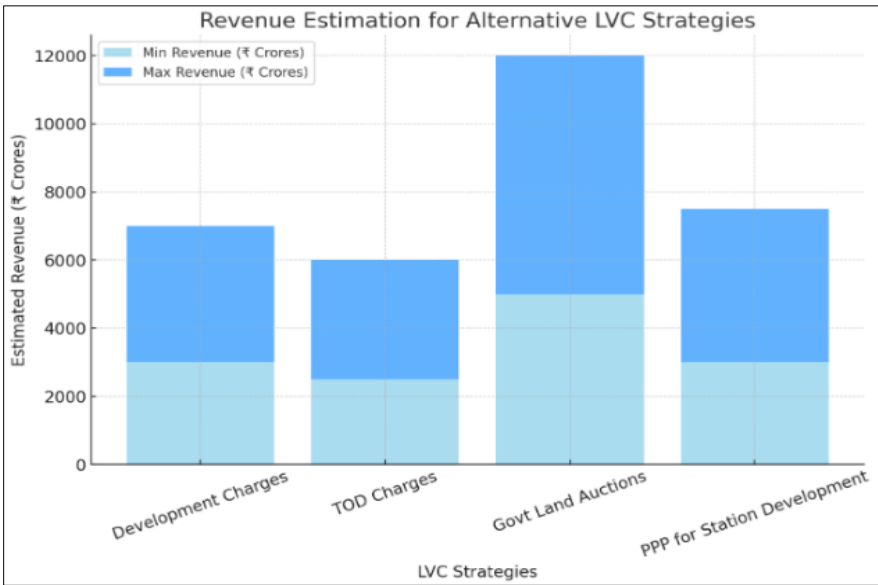
Source: Author's own creation

Metro station grading takes into account-built density, DLC land values, and commercial hubs to ensure sustainable urban development along the metro corridor. High-FAR areas like Raidurg, Ameerpet, and Punjagutta support IT and corporate growth, while Nagole, Miyapur, and LB Nagar facilitate mixed-use and residential expansion. The expected revenue from several Land Value Capture (LVC) options for Hyderabad Metro is displayed in a bar graph see figure 12. Government land auctions bring in the most money, with prices ranging from ₹5,000 to ₹7,000 crores. For station development, development costs and PPP contribute between ₹3,000 and ₹4,500 crores, while TOD charges fall between ₹2,500 and ₹3,500 crores. 50–60% of metro expenses might be covered by the combined LVC measures, guaranteeing financial stability and lowering reliance on farebox revenue.

7.0 Conclusion

The Hyderabad Metro has encouraged sustainable transportation, decreased traffic, and greatly enhanced urban mobility. It has established a standard for contemporary urban transportation and is one of the biggest Public-Private Partnership (PPP) metro projects in India. However, because farebox income is inadequate to fund long-term operations and growth, financial sustainability continues to be an issue. Land Value Capture (LVC), which makes use of betterment levies, land monetization, Additional Development Rights (ADRs), and transit-oriented development (TOD), is highlighted in this study as a feasible funding method. The effectiveness of LVC in metro finance is supported by case studies from Hong Kong, Tokyo, and London. Up to 60% of metro development expenditures can be financed by LVC with appropriate execution, relieving financial strain on both public and private investors. Issues including stakeholder concerns, regulatory obstacles, and policy alignment must be resolved to guarantee success. The introduction of LVC requires government backing, FAR-based revenue structures, and a structured zoning framework. Hyderabad Metro may accomplish long-term development, planned urban expansion, and sustainable finance by incorporating LVC into its financial model. LVC has the ability to transform metro funding and ensure Hyderabad's status as a cutting-edge, interconnected metropolis with the correct regulations and stakeholder collaboration.

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