ORF

d·i·e

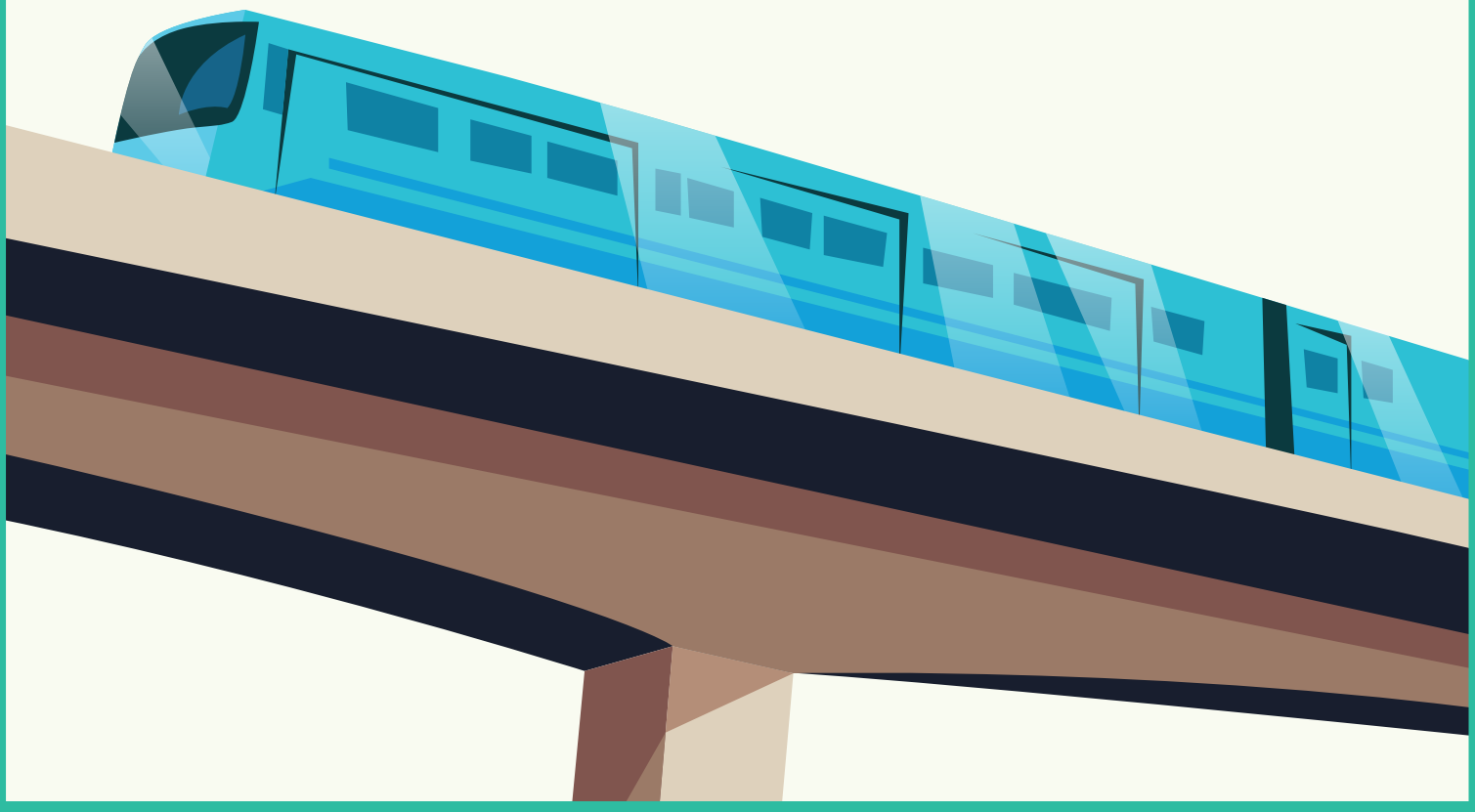
Deutsches Institut für Entwicklungspolitik

German Development Institute

ASSESSING CO-BENEFITS FROM METRO RAIL IN INDIA

Industrialisation and Land Value Capture Financing

Promit Mookherjee and Dhaval Desai



Attribution: Promit Mookherjee and Dhaval Desai, *Assessing Co-Benefits from Metro Rail in India: Industrialisation and Land Value Capture Financing*, January 2023, Observer Research Foundation.

Observer Research Foundation
20 Rouse Avenue, Institutional Area
New Delhi 110002
India
contactus@orfonline.org
www.orfonline.org

The Observer Research Foundation (ORF) provides non-partisan, independent analyses and inputs on matters of security, strategy, economy, development, energy and global governance to diverse decision-makers (governments, business communities, academia, and civil society). ORF's mandate is to conduct in-depth research, provide inclusive platforms, and invest in tomorrow's thought leaders today.

This report was prepared by ORF with support from Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and the German Development Institute (DIE). The study is part of a larger collaborative international project of the DIE and the United Nations Economic Commission for Latin America and the Caribbean (UN-ECLAC). The recommendations and the views expressed herein are, however, those of the researchers and do not reflect the formal position of the supporting organisations.

The German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE) is one of the leading research institutes on development policy. Through excellent research, policy advice and training, the Institute contributes to finding solutions to global challenges.

Design & Layout: Rahil Miya Shaikh

Contents

Introduction

Rapid population growth and the expansion of metropolitan regions are defining features of India's economic growth story. The number of Indian cities with populations above one million increased from 23 in 1991 to 53 in 2011.[1] The average population density has also snowballed to 464 persons/sq km in 2020, 13 times more than the US and three times as much as China.[2] This urban growth has led to a rapid rise in transport activity, characterised by a 10-fold expansion in registered motorised vehicles since 1990, 80 percent of which are two-wheelers and passenger cars.[3] The increased proliferation of motor vehicles, particularly private ones, has exacerbated the negative externalities of the transport sector—greater congestion in cities and a rise in greenhouse gas emissions and air pollution.

This scenario has led to greater investments in mass rapid transit systems to create more sustainable urban transport systems. This is part of a broader focus on 'moving people, not vehicles,' a key tenet of the National Urban Transport Policy (NUTP) released in 2006. In particular, heavy metro rail transit systems (MRTS) have received substantial attention at the national and subnational levels, given their ability to cater to high passenger densities (between 60,000 and 80,000 passengers per hour per direction[4]) in an energy-

efficient manner. These systems run on an exclusive right of way and can operate at average speeds of around 40 km/hr, leading to reduced travel times and improved productivity. They are also considered an ecofriendly mode of travel since the high passenger densities and dependence on electricity reduce emissions at the point of use.

The Kolkata Metro is India's oldest metro rail system, operated by the Indian Railways since 1984. However, the story of modern MRTS in India began with the launch of the Delhi Metro in 2002, with a network of around 25 km. The success of the Delhi Metro spurred other Tier-1 cities to invest in MRTS. By 2014, operational metro routes had expanded to 248 km across five cities.[5] Between 2014 and 2021, the metro network almost tripled to 733 km across 18 cities (see Figure 1). Another 1,032 km of metro networks have been approved, expanding to 27 cities by 2025. Until 2012, all the metro systems were established in cities with populations above 10 million[a] and high passenger densities. But following the 2013 guidance from the central government that cities with populations above two million could consider constructing metro rail systems,[6] even smaller cities have started to build metros. Since 2012, all cities that have established metro rail systems have populations below 10 million.[b,7] Notably, cities with populations below two million are also aspiring for metro rail systems, but their focus is likely to be on light metro systems such as the MetroLite.[c,8] The Gorakhpur Metro, currently under development, is one such example.

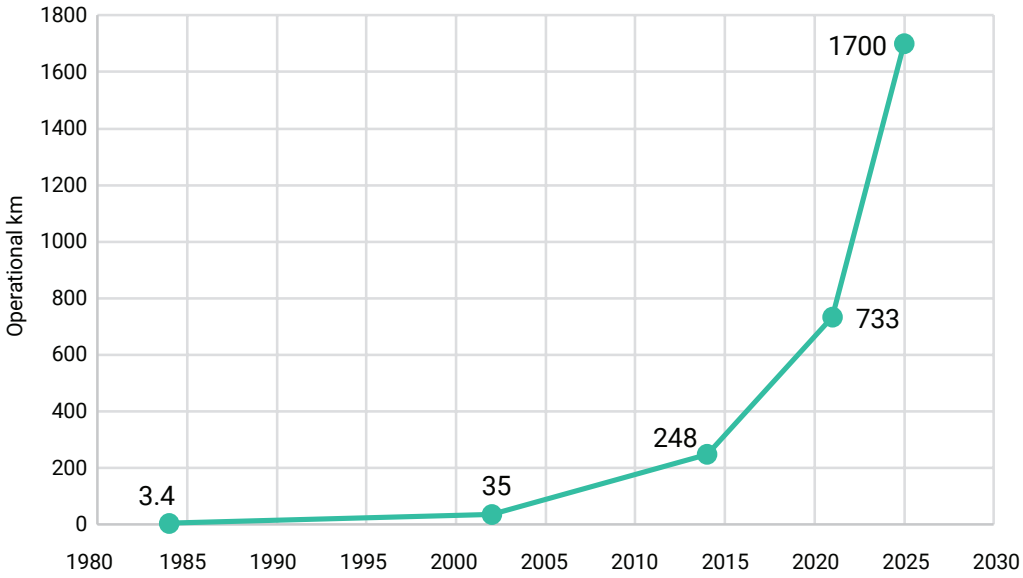
---

[a] Kolkata, New Delhi, Mumbai, and Bengaluru

[b] Agra, Ahmedabad, Bengaluru, Bhopal, Chennai, Gurugram, Hyderabad, Indore, Jaipur, Kanpur, Kochi, Lucknow, Meerut, Nagpur, Navi Mumbai, Noida, Patna, Pune, and Surat

[c] Metrolite rail, designed for lesser capacity (2,000 to 15,000 passengers per hour per direction) with lower capital investment and operations and maintenance costs, primarily cater to cities that are expected to have less ridership. Metrolite is also projected as a feeder system to the high-capacity metro.

Figure 1: Growth of Metro Systems in India



Source: Ministry of Housing and Urban Affairs

Driven by government support, metros have become India's fastest-growing mass transit system. However, metro construction and operations are highly capital-intensive, and investments have long gestation periods. Analyses of several detailed project reports reveal that an elevated metro rail corridor costs between INR 2.25 billion (US$29 million) and INR 3 billion (US$38 million) per kilometre, and an underground corridor costs between INR 5.5 billion (US$70 million) and INR 5.75 billion (US$74 million) per kilometre.[9] Since 2010, there has been a cumulative investment of around INR 20 trillion (US$25 billion) in metro rail systems, financed predominantly through partnerships between the central and state governments and concessional loans from various development finance organisations.[d] Up to 2026, approved metro rail projects have a projected expenditure of INR 3 trillion (US$3.8 billion).[10] There has been an increased focus on reducing costs and identifying alternate forms of finance to make metro rail investments more sustainable. The Metro Rail Policy 2017 aims to institutionalise some of these measures by mandating that all metro projects consider certain cost-reduction

[d] Authors' analysis based on tenders for different metros

and revenue-enhancing measures.[11] This study assesses the present status of two such interventions enshrined in the policy.

First, the Metro Policy and prior efforts by the central government have outlined a clear path to indeginising the production of all metro subsystems. This study assesses the progress towards creating domestic industrial capabilities for metro subsystems and the contribution of specific policies. It identifies the areas where the policies have been successful and the existing challenges to localisation. It also assesses the prevalent technology development models and details the long-term implications of sticking to the existing pathway. Based on this analysis, specific policy lessons are presented that can guide India's efforts in the future.

The second part of the study assesses efforts to increase non-fare box revenues from the metro rail. In particular, it looks at the progress towards implementing land value capture (LVC) mechanisms to monetise the increases in land value in metro rail influence areas. It assesses the feasibility and acceptability of different LVC tools identified in the national and subnational policies. It also examines the ability of the present governance structure to implement these mechanisms effectively and channel finances to the metro rail sector. Finally, it identifies policy measures informed by the global experience, allowing for better-integrated planning and enabling LVC practically and acceptably.

Inputs from stakeholders have shaped the direction of this research Throughout the study, the authors interacted with several stakeholders, covering government representatives, local metro rail authorities, manufacturers, railway personnel, consulting firms, and private research organisations (see the Annexure for the full list of stakeholders The study also relies on policy documents, secondary data, and existing secondary literature to validate and enhance the inputs received from the stakeholders.

All interviews were conducted without attribution to ensure a candid exchange of views. The learnings from the stakeholder consultations have been incorporated into the analyses and the policy lessons.

Metro Rail Policy in India

Metro projects in India are guided by two overarching laws: the Metro Railways (Construction of Works) Act, 1978, and the Metro Railways (Operation and Maintenance) Act, 2002. These laws lay down the procedures for establishing metro rail administration authorities, and delineate their powers and functions. The laws have formed the basis for setting up special purpose vehicles (SPVs)[e,12] to carry out metro operations, starting with the Delhi Metro Rail Corporation (DMRC). They also outline the procedures for land acquisition, determining fares, and various offences and penalties. Notably, the metro rail authorities are not given direct control of tariffs, with this power vested in a separate fare-determining committee.

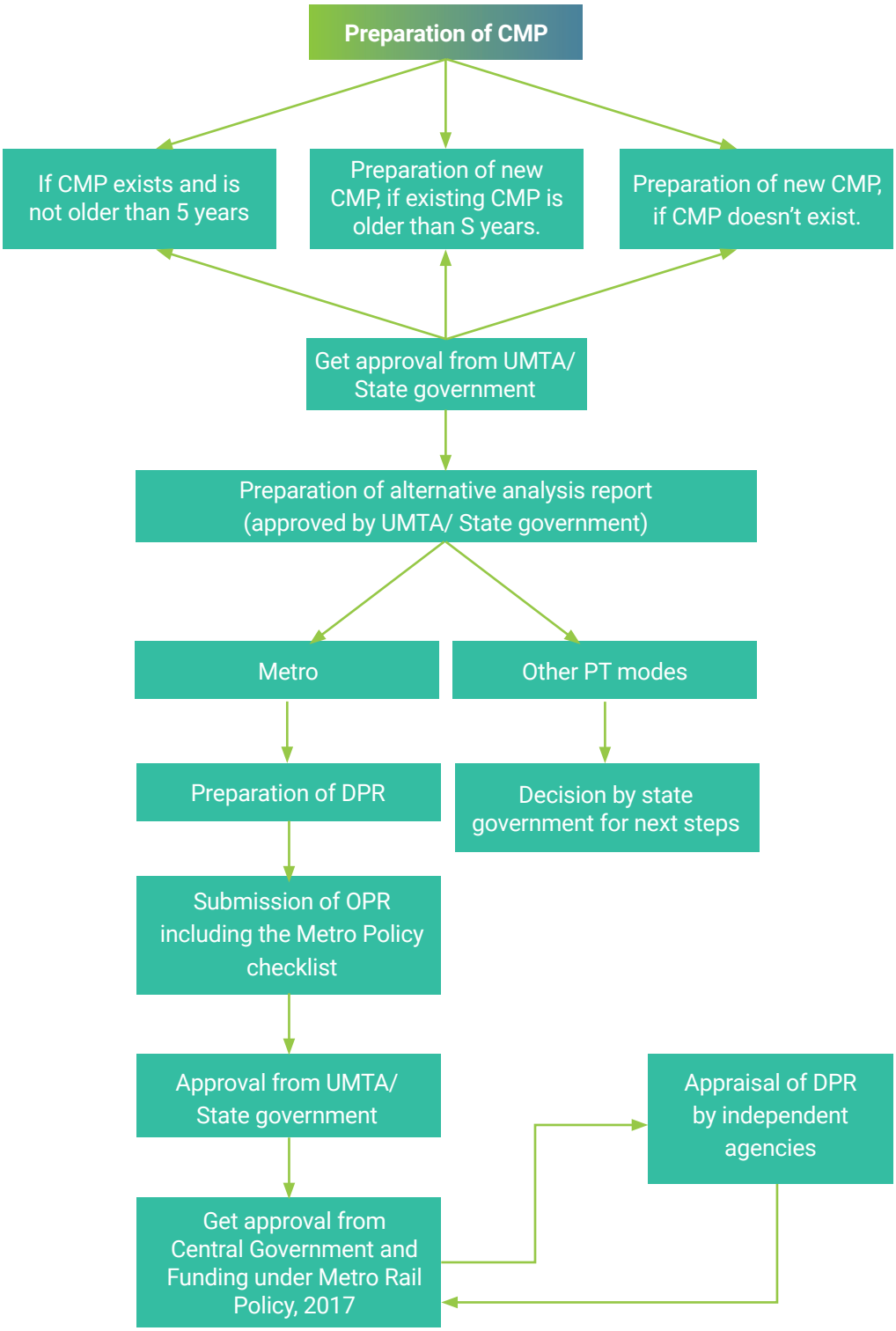
While the laws provide the legal framework, they do not offer any guidance regarding when to construct MRTS or how they should be financed. Most cities are now keen to build metro rail networks, including smaller cities

[e] A special purpose vehicle, or SPV, is a legal entity that undertakes a project. All contractual agreements between the various parties are negotiated between themselves and the SPV. An SPV is a commercial company established under the relevant Act of a country through an agreement (also known as memorandum of association) between the shareholders or sponsors.

that have limited formal transportation systems. This bias toward metro rail emerges from the need to provide mass transit systems and its "aspirational" connotations. The glut of requests from state governments for project approval and financial support led to the union government notifying the Metro Rail Policy in 2017,[13] which lays down the conditions for state governments to receive central support for their metro projects (see Figure 2).

Since most metros are financed jointly by the Centre and states, receiving central support is critical to implementing metro projects. The policy advocates for a systems approach, with metro rail embedded in a broader strategy to ensure a seamless multimodal system. To this end, any city seeking assistance for metros should have already developed a comprehensive mobility plan (CMP), presenting short-, medium-, and long-term strategies to improve mobility and justify its proposal to the central government and multilateral funding agencies. It also mandates state governments to set up unified metropolitan transport authorities (UMTAs) as a prerequisite to ensure an integrated approach to planning and management.

Figure 2: Appraisal Framework for Projects under Metro Rail Policy



Source: Ministry of Housing and Urban Affairs

The policy also acknowledges that MRTS are highly capital-intensive and most suited for cities with growing populations and favourable growth prospects. Metros should be considered for cities with high-density passenger corridors, typically with passenger volumes between 60,000 and 80,000 passengers per hour per direction. The policy mandates city authorities to conduct an alternatives analysis for the proposed metro corridor, and the Ministry of Housing and Urban Affairs (MoHUA) has also specified standard guidelines for such analyses.[14] The analysis aims to assess the financial, environmental, and social costs for the different modes of transport capable of satisfying the transport needs in the proposed corridor. The overarching objective is to select the most locally-preferred alternatives based on this multicriteria assessment. The MoHUA guidelines suggest that each criterion included in the analysis should be given a certain numeric weight, and the transport mode with the highest cumulative score should be selected for development. However, how the weights are determined is unclear, leaving the potential for bias in generating the final results. The alternatives analysis is part of a broader detailed project report, which includes additional factors such as metro alignment and design, technology selection, financing models, operational plans, and environmental impact assessment, among others. MoHUA assesses the feasibility of metros on a combination of these factors, but how the final decision is made on such a broad range of analyses remains unclear.

The 2017 metro policy also outlines specific measures to reduce costs and enhance revenues. On the revenue side, central funding will only be considered if the proposal includes plans for setting up a comprehensive feeder system to enlarge the catchment areas of every station to at least five kilometres. These feeder systems must consist of paratransit and improvements in non-motorised transport infrastructure. Furthermore, it mandates consideration of transit-oriented development (TOD) and value-capture financing in the detailed project report. All metro rail proposals must plan for TOD, focusing on intermodal integration, including paratransit and universal accessibility. They must also explicitly plan for capturing the benefits from TOD using LVC financing mechanisms outlined in the National Value Capture Finance Policy Framework.[15] The proposal should identify the quantum of benefits transferred from value capture mechanisms to the metro rail implementation agencies for executing the project. These measures,

as highlighted in the metro policy, clearly recognise the capital-intensive nature of metros and their ability to reshape land values in cities.

There is also a strong push for the indigenisation of metro rail systems to reduce costs. Metro authorities must commit to continued increases in mandatory local content in the procurement conditions. Furthermore, each metro must adhere to the standards for the different metro components and focus on bulk procurement to create visible demand for indigenous components.

The policy also advocates for increasing private participation and urges all state governments seeking central support to consider public-private partnerships (PPPs) in their proposals. This consideration can be for construction works and operational services, maintenance, and upgrades. In particular, it highlights the need to increasingly include PPPs in operation and maintenance activities since they are more profitable than construction works, which require heavy up-front capital investments.

Assessing Industrial Growth from Metro Rail Development

The successful implementation of metro rail projects consists of multiple stages and subsystems, broadly categorised as track and station construction, rolling stock, traction systems, signalling and communication systems, and ticketing systems. The recent boom in the metro rail sector globally, particularly in Asia,[16] has spurred large-scale growth in industries supplying the different subsystems. However, control over the technology needed for these different systems is still concentrated in a few firms in a small group of countries. Moreover, the recent growth of metros has been chiefly in developing nations with limited technological capabilities to produce these systems. As a result, many of these countries, particularly India, have implemented policies to build local capacities. The driving force behind this is the need to reduce costs through local production. Additional co-benefits from indigenisation include job creation, increased economic value-added, and the potential to improve exports. This section analyses India's efforts to build local metro rail system capabilities, assessing each subsystem individually.

Policies for Building Domestic Capabilities

The 2017 Metro Rail Policy identifies indigenous production as a prerequisite

for reducing costs. Even before the policy was notified, this was a priority area under the broader umbrella of the 'Make in India' programme that mandated a certain proportion of local content in the public procurement process, including metro rail. Metro rail authorities have to follow the Public Procurement (Preference to Make in India) Order, 2017, issued by the Department for Promotion of Industry and Internal Trade (under the Ministry of Commerce and Industry), which forms the basis for public procurement in India. This order defines a selection process to ensure that bidders with higher local content are given preference.[17] Firms with local content above 50 percent are classified as a 'class-I local supplier'. The selection procedure is such that the lowest bidder among class-I suppliers is awarded the contract even if this is not the lowest bid across all applicants.

MoHUA has implemented a phased manufacturing plan to increase localised content in the procurement process. Table 1 shows the most recent update (2021) to the mandated local content for the different metro rail subsystems. Given India's significant capacity to carry out most construction-related activities, civil works have the highest local value addition. There is still a dependence on foreign firms for tunnel boring equipment for underground works; hence, local content is slightly lower than for elevated sections. Rolling stock has a 60 percent mandated value addition, marginally higher than the other systems at 50 percent. The specific situation for each subsystem is discussed in detail in the subsequent sections.

Table 1: Mandated local value addition as per the phased manufacturing programme (2021)

Component	Mandated local content
Rolling stock	60%
Telecom	50%
Signalling	50%
Civil works	90% (elevated), 80% (underground)
Electrical	50%

Source: Ministry of Housing and Urban Affairs[18]

[f] Local content is defined as total value of the item procured (excluding net domestic indirect taxes) minus the value of imported content in the item (including all customs duties).

Significantly, local content is defined as the total value of the items procured minus the value of the imported content. In addition, the definition restricts itself to the value of the materials needed to manufacture an item. Thus, any firm meeting the mandated local content criteria can be eligible for the bidding process without restrictions on the firm's origin country. This has been done to encourage Indian firms and foreign firms willing to set up manufacturing facilities in India through local subsidiaries or joint ventures with Indian firms. Apart from this, the MoHUA guidelines do not distinguish between different technology transfer models, and the government has not been directly involved in facilitating technology transfers as in some other countries.

Furthermore, the cost of technology acquisition, such as licensing fees or R&D expenditures, is not accounted for in the local content. This has implications for the pace of innovation and investments in design engineering by Indian firms, discussed further in subsequent sections. As such, neither the Metro Rail Policy nor the procurement process has any specific focus on technological development or innovation.

Another effort to increase indigenisation has been the standardisation of different metro components to aggregate demand and encourage firms to scale up their local manufacturing efforts. In 2013, the erstwhile Ministry of Urban Development constituted a committee to prepare a 'Base paper on Standardization and Indigenisation of Metro Railway Systems'.[20] The paper identified the basis for setting standards for the metro subsystems based on inputs from several stakeholders, including the original equipment manufacturers. Subsequently, it also constituted individual committees for rolling stock, signalling systems, tractions systems, operations and maintenance, fare collection systems, and track structures. Each sub-committee was tasked with identifying the key challenges to the indigenisation of each subsystem and identifying standards to be followed by all metro rail authorities. The intricacies of the standards and the gaps in the current process are discussed in the subsequent sections.

Domestic Capabilities for Metro Subsystems

Track and Station Infrastructure

The infrastructure needed in the initial phase of metro construction includes civil works related to alignment and formation, station buildings, and permanent way. The basic structures differ on the elevated and underground sections of the track. For elevated track sections, almost all the civil work is

catered to by domestic firms that can source most of the equipment and materials locally. As a result, MoHUA has mandated a 90-percent localisation for civil works on elevated track sections. The major firms that have won contracts for the construction of these track sections—such as Hindustan Construction Company, KEC International Ltd, Larsen and Toubro-India, AFCONs, Infrastructure, NCC, J Kumar Projects, and Dilip Buildcon—have facilities in India.

The MoHUA has recommended using tunnel boring machines (TBMs) over traditional drilling and blasting methods for the underground track sections. However, Indian contractors continue to subcontract TBMs from foreign suppliers. The major suppliers of TBMs to India are China Railway Construction Heavy Industry Corporation Limited, Shanghai Tunnel Engineering Company (China), Terratec (Australia), Herrenknecht (Germany), and the Robbins Company (US). Notably, many non-Chinese manufacturers have also been supplying TBMs from their facilities in China. Herrenknecht, Terratec, and Robbins Company have manufacturing capacity in China, but only Herrenknecht has a manufacturing facility in India (in Chennai since 2007). The facility includes 2,2250 square metres of TBM assembly and refurbishment capacity capable of producing 10 TBMs per year. Having local facilities has provided Herrenknecht with an advantage in the Indian market, with officials claiming that their TBMs did around 70 percent of the tunnelling in 2018.[g] However, given the limited capacity in India, the company still continues to import TBMs from its facilities in China and Europe. Notably, many projects now utilise refurbished TBMs instead of new ones, which are often stored in India once a particular project is completed and then refurbished abroad for future use.[21]

Multiple factors have contributed to the lack of TBM capacity in India. China's existing capacity in China is a key hindrance since foreign suppliers with large plants in that country already enjoy economies of scale and an existing ecosystem for sourcing raw materials and components. Most are unwilling to replicate the large capital investments required to setup facilities in India when they already have established export routes from China. Although there was

[g] A more detailed break up of the TBM market was not available and was beyond the scope of this study to estimate.

zero custom duty on TBM imports, a seven percent duty has been levied since 2021 to boost local manufacturing. Yet, these machines continue to be taxed domestically in the 18 percent GST bracket, leading to increased costs. Another factor has been India's underdeveloped logistic systems. TBMs consist of multiple parts, most of which have to be customised for different projects, and the long delivery times associated with components are a significant hurdle. This also forces companies to maintain a high spare parts inventory, adding to the manufacturing cost. Improving logistics is a key aim of the central government's *Gati Shakti* (National Master Plan for Multi-modal Connectivity) scheme. If the scheme can substantially improve connectivity and the domestic taxation structure on TBMs is rationalised, more manufacturers may be inclined to set up facilities in India.

For the stations, which broadly include the concourse and platform levels, the civil works are almost exclusively carried out by firms based in India utilising local labour and materials. For the electrical and mechanical items, on the other hand, there is still a substantial dependence on imports. But there has been some change since 2018 when a MoHUA committee put down standards for electrical and mechanical systems for all metro projects. The electrical systems broadly include low voltage panels, distribution boards, cables, wiring, lighting system, earthing system, and the uninterruptible power supply. For these systems, there is already some capacity to manufacture within India and the MoHUA mandated a 50 percent local content requirement. Still, there is an import dependence for certain items because there is also high demand from other sectors. Furthermore, in some cases, the quality of imported products are considered to be of better quality than the local versions.

Underground stations also require two other systems—the environmental control system (ECS) and the tunnel ventilation system (TVS). The automated ECS system consists of heating, ventilation, and air conditioning equipment. Many of the components needed for these systems are already being manufactured in India by established suppliers such as Daikin, Bluestar, and Voltas. MoHUA has already mandated 50 percent local content for ECS contractors. However, certain critical system parts, such as chillers, are still imported. For TVS, the MoHUA committee had highlighted that most critical components, particularly the tunnel ventilation fans (TVF), exhaust system, dampers, and booster fans, were heavily dependent on imports even in 2018. However, it stated that for the TVF and exhaust systems, 75 percent of the required components

could be mandated to be manufactured or assembled in India by 2019. Since then, some capacity has been built locally, with tenders for some newer metro projects giving preference to suppliers that can guarantee 60 percent local content. Some metro projects have also decided to award the ECS and TVS contracts as a turnkey solution.

Overall, there has been substantial progress in terms of building up local capabilities for the electronic components used in the stations. The firms engaged in these systems have also shown a greater inclination to set up local facilities as the demand for these products is expected to rise from metros and other sectors.

Traction Systems

On traction systems, the MoHUA committee recommended the adoption of either the 25 kV AC or 750 V DC third rail system for Indian metros.[22] The 25 kV AC overhead catenary's propulsion system has two additional components than the 750 V DC third rail system—the transformer and front-end converter. As such, although the MoHUA committee suggests that the quoted costs for both these systems are similar, the 25 kV AC system could have slightly higher rolling stock costs. The third rail system is also considered more aesthetically pleasing, which may be a significant factor for the local authorities. However, the overhead 25 kV AC system is recommended for higher passenger densities due to its greater energy efficiency with heavier loads. The committee also suggested that the 1500 kV DC overhead system can be considered.

Many early projects, such as the initial phases of the Delhi and Mumbai metros, opted for the 25 kV AC overhead catenary systems primarily because Indian engineers already had significant experience with these systems as they were used by the Indian Railways. But the more recent projects have preferred the third rail system.

The choice of traction system has implications for the level of localisation. First, the choice of traction affects the demand for propulsion systems. Having multiple traction systems across cities could lead to lower demand aggregation, translating into lower investment in domestic manufacturing capacity. Second, the level of localisation possible for the traction and power systems differs across the two technologies. As per a 2018 MoHUA report,[23] the overhead catenary system already has a localisation level above 50 percent, and only specific components, such as the conductor rail and its fittings, are dependent on imports.

However, the components for the third rail system—such as the aluminium rail, circuit breakers, transformers, and cables—are largely import-dependent. The contracts for these systems are currently being serviced by overseas firms with production facilities abroad, sometimes through their Indian subsidiaries.

The increased proliferation of the third rail system could thus have implications for the level of localisation possible for traction systems. Furthermore, since the demand for these systems is limited and fragmented, it will be difficult to convince manufacturers to put in the heavy capital investments needed to create facilities to produce these components locally. Since the production process for these components is also largely automated, any labour cost advantages in India might be minimal.

This is not to say that metro rail authorities should select the traction system based on the level of localisation. The focus should be on the most cost-effective solutions, and the committee has comprehensively analysed the different tradeoffs associated with these systems. The standardisation has also helped simplify the process for metro authorities to select the right traction system. It might be worthwhile to regularly update the committee's recommendations, given that the last advice was based on information from 2012. Since then, far more data has been gathered from the different metro rail experiences, and the cost of these systems might have evolved, as was suggested by the committee at the time. This analysis could also add the two new metro systems that have been proposed, the MetroLite and MetroNeo.[h,24] These are supposed to be cost-effective alternatives to heavy metro rail systems for corridors with lower passenger densities. They provide an exciting new opportunity, but metro rail authorities are still uncertain regarding the criteria for choosing these systems. The benchmarking and standardisation of the cost and comparison with existing systems will be crucial to increase the uptake of these systems.

[h] MetroNeo is an articulated or bi-articulated trolley bus system with overhead electric traction, perceived as a transport solution for Tier-2 and Tier-3 cities for 8,000 passengers per hour per direction and extendable upto 10,000.

Rolling Stock

Rolling stock is a critical part of any metro rail project and accounts for approximately 30 percent to 40 percent of the total cost of that project. The rolling stock for the metro rail is different from those used in traditional rail systems primarily due to the higher prevalence of electrical components. Globally, metro rolling stock technology is concentrated in a few firms in developed nations. China's state-owned CRRC Corporation Limited caters to 67 percent of the global metro rail rolling stock market.[25] However, CRRC's growth has been mainly driven by domestic demand, which contributed 90 percent of its operating revenue in 2017. Notably, although CRRC has developed technology competence, it was previously heavily dependent on foreign suppliers for designs and technology.

In contrast, the early movers in developing metro rail technologies are based mainly in Europe. Manufactures like Alstom, Bombardier, CAF, and Siemens have utilised their first-mover advantage to become the leading rolling-stock technology exporters to most countries that are now establishing metro rail systems. However, developing countries have increasingly tried to build domestic capabilities and reduce their dependence on direct imports. India has had significant success in this regard, with multiple manufacturers setting up facilities within the country, each with its own technology transfer and content localisation strategy.

When the Delhi Metro started in 2002, rolling stock was primarily imported, with some work subcontracted to Indian manufacturers. Much has changed since then, with a steady buildup of manufacturing facilities for metro rail rolling stock. Delhi Metro claims that 90 percent of its coaches are produced in India.[27] The increased capacity to produce locally has also prompted the MoHUA to set standards for the proportion of rolling stock that must be produced within the country. As per the most recent circular (2017), at least 75 percent of the tendered quantity of cars in any procurement order must be manufactured within the country, either by establishing an exclusive facility or in partnership with Indian manufacturers.[28] This is in addition to the local content requirements, which mandate 60 percent local value addition for rolling stock. These two measures are key to ensuring that the tendering process is skewed towards domestic manufacturing.

However, neither of the conditions related to localisation specify any conditions related to the nature of technology transfer or country of origin for a particular manufacturer. As

a result, both foreign and domestic suppliers have adopted different models for setting up manufacturing facilities in India. So far, five major rolling stock manufacturers have catered to the bulk of the demand.

Rolling stock for the metro rail consists of two broad components, the train's body and the propulsion system. Some manufacturers provide integrated solutions by providing both systems, while others engage subcontractors for the propulsion systems. The different strategies adopted by some of the major manufacturers are detailed below, with a specific focus on their localisation strategies:

- **Bharat Earth Movers Limited (BEML):** BEML, a public sector undertaking under the Ministry of Defence, manufacturers heavy equipment for defence, construction, mining, and rail and metro rail coaches. The first set of rolling stock contracts for Phase-1 of the Delhi Metro was awarded to a consortium of Hyundai Rotem and Mitsubishi Corporation, with BEML as a subcontractor. In this instance, 220 of the 280 cars were manufactured by BEML at its Bengaluru facility. Hyundai Rotem provided the design for the metro cars. At this stage, most of the components, including the cars' propulsion systems, were still imported.

Since then, BEML has taken great strides in developing its in-house capacity to build rolling stock. In 2018, it won a contract worth INR 30.15 billion (US$388 million) for Mumbai Metro.[29] The company now says that local content accounts for 65 percent of the value of its rolling stock. However, this is limited to the car body and bogey production. Critical components like the propulsion system are still outsourced to foreign firms like Mitsubishi. Furthermore, BEML's design capacity is still limited, and the design aspects for the metro trains are outsourced to foreign firms. To rectify this, the company signed a memorandum of understanding in 2021 with Rail India Technical and Economic Service to collaborate on developing design capabilities.[30] As it expands its R&D capabilities, the hope is that BEML can increasingly come up with indigenous designs for its trains, which will help increase localisation while reducing the cost of production and expenditure on subcontracting. Having in-house design capacity will also allow it to adapt its design to cater to the export market and the

ever-changing domestic market, where demand for newer metro rail designs, such as the MetroLite, is likely to increase.

- **Alstom-Bombardier:** Alstom SA is a French multinational company that manufactures rolling stock and other metro systems. It is one of the oldest rolling stock manufacturers globally and one of the first companies to enter the global market for manufacturing metro rail systems. Alstom SA entered India by establishing a fully-owned subsidiary, Alstom Projects India Ltd, in 1992. Since then, it has expanded its operations to cater to multiple areas, including the power sector. Alstom Transport India is now one of the major domestic suppliers of metro rail rolling stock, with multiple manufacturing facilities in India.

  In 2021, Alstom SA acquired Bombardier Inc. and took over its manufacturing facilities in India.[31] Today, the company has two dedicated facilities for manufacturing metro coaches and two more component manufacturing facilities. Alstom-Bombardier's Coimbatore plant is the largest component manufacturing facility in Asia, with an average investment of €25 million (US$26.5 million). It is also supposed to generate 10,000 direct and indirect jobs, indicating the significant employment potential of the component industry in India.[32] Furthermore, it has also established two engineering facilities in India, a significant move in terms of creating local design capacity.

  Interactions with former Alstom executives revealed an initial dependence on their foreign counterparts for the train designs. However, this dependence hindered the ability to localise the sourcing of different components, translating into higher production costs and non-competitive bids. This was the key driving force behind the increased focus on localisation and creating design capacity within India. The company focused on hiring Indian engineers and training them through foreign exposure to design India-specific trains with high levels of localisation. Alstom's increased competitiveness is due to the cost reductions achieved by increasingly designing in India. It is also one of the few firms capable of providing turnkey solutions to metro rail authorities covering

rolling stock, propulsion systems, and signalling and communication equipment.

The Alstom experience is a good example of how foreign subsidiaries can adapt to local markets and become competitive by being flexible in their design engineering. Now, the company caters to the local market and also exports trains manufactured in India to different parts of the world, including Sao Paulo in Brazil, Riyadh in Saudi Arabia, and Sydney in Australia. Notably, they also claim to have provided engineering services from India for its parent projects in other countries. The cheaper cost of engineering services in India and a readily available talent pool have been the driving forces behind establishing design capabilities in India. This is especially true for firms with existing design capabilities and the ability to upskill Indian workers through collaborative knowledge-sharing with their foreign counterparts.

• **Titagarh-Firema:** Titagarh Wagons Ltd is an Indian company established in 1997 with the primary purpose of manufacturing freight wagons for the Indian Railways. Since 2007, it has also manufactured passenger trains and has ventured into defence equipment manufacturing. The company began its foray into manufacturing metro rail rolling stock more recently. Notably, their model of technology acquisition has been different from their competitors. In 2015, it acquired the Italian rolling stock manufacturer Firema SpA, thereby gaining control over its technology for metro rail rolling stock and propulsion systems. This has made them the first completely Indian company to have the designs and technology needed for rolling stock production. Since then, it has developed the capacity to manufacture metro cars from its existing facilities in West Bengal and has access to Firema's facilities in Italy.

It has also set up design capabilities in India, with engineers here actively collaborating with their Italian counterparts. In 2020, it bagged an INR 11.22-billion (US$135 billion) contract to supply 33 train sets of three coaches each to the Pune Metro. Three of these sets were to be manufactured in their Italian plant, while the rest are to be manufactured in India. In 2021, they unveiled the first three

trains for Pune, the first aluminium-bodied metro trains in India. The company believes that its in-house design capabilities and control over technology will allow it to innovate faster than its competitors, leading to quicker cost reductions and the use of localised content.

Thus, the growth of metro rail has spurred a notable increase in domestic capabilities for producing rolling stock (see Table 2). There is now significant competition in the rolling stock market, with several newer players. This is a result of increased foreign direct investment (FDI) in this sector and greater investment from Indian companies. There is a clear focus on increasing localised content across the board, and most manufacturers now claim to have localisation levels above 80 percent. The strict procurement conditions may have played a part in this. Still, most suppliers stated that their primary motivation for localisation was to reduce costs to better compete in a crowded market. MoHUA's recommendations on rolling stock standardisation have also played a key role in aggregating demand.

Table 2: Snapshot of rolling stock manufacturing capacity in India (as of January 2022)

Company	Coaches Supplied	Local Facilities
Alstom-Bombardier	2,500	Two manufacturing facilities Two-component manufacturing facilities
CRRC	598	Two upcoming facilities
Bharat Earth Movers Limited (BEML)*	1,500	One facility
Titagarh-Firema	102	One facility

*Some coaches were supplied as a subcontractor for Hyundai Rotem and Mitsubishi.
Source: Compiled from manufacturer brochures and stakeholder consultations.

However, domestic production capabilities for niche components, especially propulsion systems, are limited. The propulsion system is the driving force of the train and consists of the traction motor, main converter-inverters, auxiliary converters, and the train control and management system. India's prominent propulsion system suppliers include Siemens, Mitsubishi, Toshiba, and Melco. Established rolling stock suppliers such as Alstom and Bombardier also produce these systems and can provide integrated solutions by manufacturing the body and the propulsion system. However, there is still limited local capacity to produce these systems. The Indian Railways has also traditionally depended on imports for these systems. In 2019, Siemens announced that it had been provided India's first indigenously designed and developed propulsion system to the Indian Railways.[33] Although the Indian knowledge content for this system is not clear, it is an example of standard expertise from Siemens being brought to bear in an Indian context.

Similarly, these systems were also wholly import-dependent in the initial stages of India's metro rail development. More recently, there have been some positive signs with some manufacturers setting up factories in India. In 2015, Mitsubishi set up a factory in Bidadi, Karnataka, which now produces propulsion systems, particularly for BEML. Alstom also has set up two-component manufacturing facilities to produce these systems. Titagarh's acquisition of Firema has also given them access to technologies to make these systems in India and their plant in Italy. It is plausible that most of these systems could also be localised.

MoHUA's committee on rolling stock deliberated extensively on ways to accelerate the indigenisation of propulsion systems. The point of contention was whether to make it mandatory for suppliers to provide the car and propulsion systems as a single source, either on their own or through a consortium. The argument for the consortium approach was that the integration of the different systems would be smoother and encourage manufacturers to expand their domestic capacity for these systems. The main proponent of this argument was Alstom, which could provide such turnkey solutions. However, this could also have led to market monopolisation by certain players and increased costs in the long run. Instead, the subcontracting approach, where car manufacturers are allowed to subcontract the propulsions system, would allow more players to enter the bidding process. Furthermore, the car manufacturers would have enough negotiating power to decrease costs. In the end, the committee recommended that the bidder could

adopt either approach. This seems to have paid dividends, with increased competition in the market driving down costs substantially.

Another issue pertained to the eligibility criteria for propulsion equipment manufacturers to qualify for the bidding process. Presently, the entry criteria mandate that propulsion manufacturers have a cumulative experience of 10 years. They must also have supplied a minimum of five contracts in a country other than India. This heavily skews the bidding process to favour legacy manufacturers and explains why newer Indian players are not adequately incentivised to enter the market. However, to develop indigenous capacity, the committee recommended that metro rail authorities consider giving out development contracts to Indian manufacturers for propulsion systems. There has been a reluctance to follow this approach since most metro rail authorities are trying to reduce costs and minimise risks associated with such deals.

Overall, India's metro rolling stock industry is a great example of how increased demand and competition can drive industrialisation in a nascent sector. The increased domestic capabilities have already translated into a lower cost of production. The average cost per coach is below INR 10 million (US$128,900) compared to INR 15 million (US$193,323) in the initial stages of metro rail development. As demand increases and design capabilities in the country also improve, further reductions could become evident. The last section provides some recommendations for accelerating this process.

Signalling and Communication Systems

The signalling and communication systems ensure the safety of train movement while also ensuring operational efficiency by allowing optimal headways. The demands from these systems differ substantially between traditional mainline operations and metro rail operations. Metro systems transport high passenger densities over shorter distances with more frequent stoppages, whereas mainline trains move passengers over longer distances. The mainline operations have been traditionally dependent on fixed block-based signalling systems with headways predefined by the blocks' lengths. On the other hand, the peculiarities of metro rail have led to more focus on automated systems for train detection and interlocking. This is essential to provide the higher order of safety needed to maintain the smaller headways needed for efficient metro operations.

Considering this, MoHUA has recommended that metros in India

focus on communication-based train control (CBTC) systems as the gold standard.[34] CBTC is a continuous communication system between the train, the track, and the control centre (see Table 3); the equipment onboard the train constantly communicates with the equipment on the track so that the train can be tracked in real-time. Thus, the blocks based on which the distance between two trains is maintained are constantly moving, allowing for trains to operate with shorter distances or headway between each other. The main benefit of this system over the traditional fixed block system is that it allows trains to run closer to each other with greater control over train operations.

Table 3: Components of the CBTC system

Subsystem	Description
Automatic train supervision (ATS) equipment	- Installed at communication centre and wayside. - Identifies tracks and displays trains to the control centre - Provides manual and auto route setting capabilities - Controls train movement to maintain the operating schedule
Wayside equipment	- Network of controllers based on electronic processors installed on the track - Interfaces with on-train equipment, interlocking equipment and ATS - Provides positioning reference to train-borne equipment
Train-borne equipment	- Processor-based controllers, speed measurement equipment, and sensors for determining the location - Responsible for train location, speed enforcement, and function of ATS
Data communication equipment	- Located at the control centre, wayside, and on-board the train - Performs data communication within the train and with the other data centres

Source: Ministry of Railways.[35]

While the Indian Railways has some capacity to implement a fixed block-based signalling system, the technology needed to implement CBTC systems is primarily concentrated in the hands of a few European firms. Most of these firms have set up large manufacturing bases in Europe, from where these technologies are supplied to all geographies, ensuring a certain level of standardisation.[36] For Indian metros, CBTC has primarily been supplied by Alstom and Siemens, with Thales, one of the most prominent players globally, securing some contracts. Discussions with stakeholders suggest that these systems, particularly the software and testing associated with the ATS subsystem, are very costly to develop. To set up the capacity to design these systems in India would require significant investments from existing foreign vendors, which is not an attractive proposition given the limited demand. Thus, MoHUA recommendations were also not too optimistic about the complete indigenisation of these systems. However, the latest guidelines mandate that 50 percent of these systems must be localised by encouraging foreign manufacturers to source at least the hardware from within the country.

The mandated local content has increased local sourcing of hardware components, including processors, switches, cables, and track works. Some data preparation and verification work is also being done in a few local centres. However, the critical software components are still unavailable locally, and foreign firms are not inclined to design an India-specific CBTC system. Taking cognisance of this, the Delhi Metro developed an in-house signalling software system. The process has taken some time, but a big breakthrough came in 2021 when the DMRC launched an indigenous ATS system, the i-ATS. In their communication to the authors,[i] DMRC stated the following:

"As part of the 'Make in India' initiative, Government of India decided to indigenise the CBTC technology. DMRC, NITI Aayog, MoHUA, Bharat Electronics Limited (BEL), Research Design and Standards Organisation of the Indian Railways, and the Centre for Development of Advanced Computing (C-DAC) are part of this development. To take the project forward, DMRC and BEL had entered into an MoU last year. A dedicated team of DMRC and BEL, Ghaziabad, worked together round the clock to take this important step."

[i] Via email in January 2022.

The i-ATS is currently undergoing final trial on the Delhi Metro's Red Line and is expected to be deployed on certain routes. This will be a major step towards reducing dependence on foreign vendors, reducing costs, and a major technological success for India. i-ATS is a notable example of how collaboration between government agencies and research institutes can lead to technological breakthroughs when the private sector does not have enough incentive to design country-specific technologies.

Assessing the Role of Industrial Policy

The rapid growth of metro rail in India has spurred significant actions toward building domestic capabilities for its different subsystems. The most notable success has been for rolling stock, which has seen increased domestic manufacturing through foreign investments and domestic firms boosting their capacities. Specific FDI data is not available for metro rail, but FDI for railway-related components has increased rapidly, from US$25.40 million in 2011 to US$598.63 million in 2021, a sizeable share of which can be inferred to be from metro rolling stock.[37]

It is pertinent to question the driving force behind the increased technology development and transfer that has enabled industrial growth. Government policies for technology development can be classified as selective (vertical), functional (horizontal), or both. Selective policies involve the purposive targeting of certain activities or picking winners in a particular technology transfer model. They can involve favouring FDI or direct government involvement in the technology transfer to certain domestic entities, usually large public sector-owned enterprises. Functional interventions aim to improve the market and leave it free to operate or influence the direction of growth by setting specific national priorities.[38]

India's Metro Rail Policy focused on creating the right conditions for domestic manufacturing without specifying any particular technology transfer model. In contrast, governments in other countries have been directly involved in transferring technology from foreign firms to domestic counterparts. One example is the high-speed rail in China, where the Ministry of Railway facilitated the technology transfer, which entered into train procurement and technology transfer contracts with targeted foreign firms. As per the contract, the foreign firms were required to jointly develop train designs along with local counterparts while also providing access to train blueprints, manufacturing procedures, and the

training of engineers. The task of developing indigenous technologies, based on the learnings from foreign firms, was then passed on to local manufacturers. In this case, the principles of design or supporting data were not transferred to the local firms. Still, they had to develop their designs by reverse engineering based on the prototypes received from foreign firms.[39]

In India, this process has been more market-driven. The role of the government has been to set the priorities at a national level without interfering in the actual technology transfer process. These priorities are related to the level of local content through mandates in the procurement process. Thus, India's initial metro rail systems were based on foreign designs. However, the existing capabilities for rolling stock manufacturing for the Indian Railways allowed some initial cars to be subcontracted to BEML.

Since then, there has been some buildup of design capabilities in India. It is clear from discussions with stakeholders that India's on-shoring of design capabilities was due to increased competition in the market and the need to reduce costs. Another reason for the increased competition is that government priorities did not focus on turnkey solutions but allowed the market for each subsystem to develop individually. As a result, there has been no monopolisation of the market by firms with the capability to provide all the subsystems. This is in contrast to other countries that have favoured turnkey solutions since they allow for better system integration. The instance of Indian firm Titagarh directly acquiring foreign technology also represents a new paradigm in technology transfer, is likely to increase competition, and further push foreign and Indian firms to improve their design capabilities.

The other side of the coin is that certain systems, such as propulsion and parts of traction and signalling systems, still lack indigenous manufacturing and designing capabilities due to technological complexities associated with these systems. For these systems, the national priorities for local value addition have led to a certain level of local materials sourcing. Still, control over technology for these systems is yet to be indigenised. Here again, the Metro Rail Policy has not attempted to force technology transfer. Without adequate competitive advantages to export these systems from within India, it is unlikely that voluntary technology transfer from foreign firms will happen soon. However, in the case

of developing a domestic signalling system, the DMRC experience is a great example of how investment in R&D and increased collaboration between the public sector and research institutes can spur innovation when the market fails to facilitate technology transfer. Such models need to be explored for the other subsystems that lack domestic capacity. Metro authorities can aid in this by giving exploratory development contracts to Indian manufacturers in public and private sectors to encourage them to innovate in these areas.

Increasing technological design capabilities within the country is essential to maximise the co-benefits of metro development by:

1. Employing India's existing large engineering talent pool
2. Allowing for even greater content localisation, providing a fillip to the component industry, and becoming another economic value-added and employment source
3. Enabling Indian manufacturers to further utilise competitive advantages domestically and make the country a major exporter in the rapidly growing market for metro systems.

Based on the experience, the main factors influencing increased investment in design capacity are competition and the clear communication of future demand. Thus, going forward, the role of government will be to maintain a stable policy framework while identifying methods to better aggregate demand.

Maximising Co-Benefits From Local Manufacturing: The Way Forward

Given the success in creating domestic capacity, there is no need for policymakers to make any drastic changes to India's indigenisation strategy. Most stakeholders agree that a stable policy framework will be necessary to ensure the further buildup of manufacturing facilities. Still, some minor changes could help motivate firms to increase their investment in this sector. Some of the key policy learnings are highlighted below:

- **Better demand aggregation:** A key criterion identified by stakeholders for increasing investment in domestic capabilities was clear communication of future demand. Each metro authority puts out a tender for the different subsystems in an ad hoc manner. The approval for metro projects also does not follow a clear pattern or a coherent roadmap. This makes it difficult for suppliers to plan their future

investments in these segments. The central government can help coordinate this process and periodically send out a projected demand for rolling stock and other subsystems for the next five years. A centralised procurement system, where the tenders are floated by MoHUA or a specific body tasked to do so, could also go a long way towards demand aggregation.

Furthermore, the present tenders for rolling stock require a single firm to deliver all the trains for any particular order. This can often lead to delays as a single firm may not be able to produce the required coaches in the given time frame. Instead, if the order could be broken up and different firms could supply parts of the same order, it would create more demand while ensuring quicker fulfilment of each order. Since the specifications for rolling stock are already standardised, the incompatibility issue is unlikely to be a major one. Even if the trains have slightly different designs, they can still cater to the specific system.

- **Greater focus on development orders:** Indian Railways has utilised development orders to local firms to create domestic capacity for specific systems. These are special contracts given to a specific Indian firm even if they do not meet the inclusion criteria for a particular tender with further guarantees on future purchases. However, only a certain part of the complete tender quality can be given as development orders, usually between five percent and 10 percent. This essentially encourages Indian manufacturers to invest in the production of certain components or systems that they would have otherwise avoided. A similar approach should also be encouraged, or even mandated, for certain systems, such as the propulsion equipment and third rail traction, to incentivise local firms to develop these capabilities. There is also great scope to utilise the extensive research capabilities within the Indian Railways to design some of these systems within India collaboratively.

- **Measured increases to local content mandates and import substitution:** The local content requirements have set the right priorities for domestic manufacturing and technological development for the metro rail

subsystems. However, going forward, local content for certain systems, such as signalling and communication equipment, will need to be increased in a measured way to ensure that the overall growth of the manufacturing ecosystem is not hindered. Since competition has been the driving force behind innovation in this segment, manufacturers have already utilised comparative advantages to localise as much as possible. The localised systems and components will require significant investment that may not be profitable. Furthermore, localising some of these components, such as the chips used in these systems, may not yield substantial economic gains in terms of employment and value-added. Forcibly inducing local content may hamper production in such cases, and the costs may not justify the benefits.

- **Promoting innovation:** While much success has been achieved in manufacturing many metro subsystems locally, there remains a limited ability to design these systems in India. Policies for local manufacturing have largely ignored the need for technological development and R&D. Increasingly, governments and metro rail authorities must think about how they can encourage increased spending on R&D within the country. This can be done by incentivising R&D spending through tax breaks or preferential treatment for locally developed components in the procurement process.

  Furthermore, India focuses on innovation through broader policies, such as the Science, Technology, and Innovation Policy (STIP). The policy focusses on increasing investment in R&D, with the period between 2010 and 2020 declared as the 'decade of innovation'. However, these policies do not have separate provisions for newer green technologies and thus do not always link directly to the innovation needed in specific industries. Going forward, there is a need to prioritise innovation in sector-specific policies and to link those with existing provisions available in the overarching innovation policies. Increased collaboration between research institutes, industries, and metro authorities could also lead to commercialising various new technologies across subsystems,

as has already been witnessed in signalling systems.

- **Standardisation versus innovation:** The standardisation exercise carried out by MoHUA has been successful in aggregating demand and sending the right signals for increased investment in local capabilities. However, a rigid standardisation process could discourage the innovation needed to develop local knowledge for the different metro subsystems. A clear causal relationship between standards and innovations is yet to be defined; the relationship also differs according to the type of technology in question.[40] The benefits of standardisation are relatively clear—they promote the development of economies of scale while maintaining quality. At the same time, it can also lead to market monopolisation if the standards are skewed towards technologies that favour certain suppliers with significant capabilities in these technologies or through strong intellectual property rights protection.

  On the other hand, standards are also postulated to promote innovation if they are flexible and framed in a deliberative manner. Essentially, the standardisation process can be used as a knowledge-sharing and knowledge-production process if it can be made into a common platform to bring together actors with different capacities and knowledge, including the research community and industry. Also, the standards contain a codification of knowledge and can encourage newer firms to focus their innovation within the bounds set by the standards, often leading to more effective scaling up of these innovations.

  Going forward, some improvements can be made to the standardisation process in India. A clear process, focusing on an open and consultative approach, should be defined for setting the standards. The discussion should not only include the established suppliers, as is the case now, but also newer firms with the potential to innovate and research institutes with experience in research on metro subsystems. Furthermore, the standards should be updated at regular intervals to ensure that they do not lead to lock-ins with old or inferior technologies. As much as possible, the mandated specifications should also

be technology-neutral and performance-based. Finally, for some subsystems, the standards should allow for more leniency if it can lead to greater innovation. This can be particularly true for traction systems since many new cities opting for metro rail have lower passenger densities than envisaged in the initial metro standardisation process. In these cities, traction systems other than the two mandated by the MoHUA may be more cost effective and even more suited to localisation.

Conclusion

The growth of metro systems in India has already been accompanied by a substantial buildup of industrial capabilities, although some subsystems still have a long way to go. This section has outlined the unique factors that have shaped the growth of domestic capabilities, essentially a combination of targeted industrial policy, an open economy, and competition.

However, while the success thus far is commendable, enabling continued growth will require a balancing act to ensure that a more inward-looking industrial policy does not come at the cost of overall growth and innovation. Both policymakers and private players will need to focus more specifically on innovation and R&D. The next shift will have to be from just 'Make in India' to 'Design in India'. This focus and increased public-private research collaboration are also essential if India is to develop capacities for producing some of the subsystems that are still nascent domestically. If India can successfully manage this balancing act and be at the forefront of producing the latest metro technologies, it will not only be able to satisfy its domestic demand for most subsystems but also become a reliable exporter globally, particularly for the developing countries.

Assessing Land Value Capture Financing

Metro rail projects are capital-intensive. For example, Mumbai's eight metro rail corridors are estimated to cost about INR 722 billion (US$9.62 billion[j]) up to 2034, as per the CMP prepared by the Municipal Corporation of Greater Mumbai (MCGM).[41] Similarly, the three phases of the Bangalore Metro, spread over 276 km, are estimated to cost nearly INR 895 billion (US$11.93 billion).[42]

The constraints on borrowing capacity and the limitations of internal coffers and state or central grants are inhibiting factors for such large-scale infrastructure development. Additionally, given the political sensitiveness of increasing farebox revenue,[k] their operations, long-term maintenance, and upgrades pose a challenge for the states and operators. Therefore, to explore newer revenue streams from owned assets and exploit the increase in land value, states across India are resorting to land-based financing for metro development based on land value capture (LVC) principles.

---

[j] At exchange rate of INR 75 to US$1

[k] Farebox revenue refers to all revenue collected from fare-paying passengers either in the form of cash or pass sales.

Practised worldwide, LVC leverages the benefit that accrues to private land and properties in the direct "influence zone" of new infrastructure corridors and the corresponding public investments made for the purpose.[43] Land value appreciation resulting from infrastructure development is captured by deploying relevant LVC tools and reinvesting to maintain the infrastructure created or finance new public projects, forming a virtuous cycle that creates, realises, captures, and reinvests. Steps other than direct public investment by the government cause such land value enhancement. Therefore, it differs from user fees levied by the operator for service provision and allows governments and infrastructure development agencies to launch new projects despite the small resource base at their disposal. LVC provides an opportunity via executive authorisation or risk-sharing for public projects for private stakeholders.

Several cities globally have reaped the benefits of LVC by implementing TOD policies by enabling mixed-use development in proximity to and oriented to metro rail transit systems.[44] Typically, city governments have leveraged LVC through direct capital investments and offering diverse development incentives, further enhanced by levying various fees for private development within the TOD zones. They have suitably altered planning and zoning layouts to local demand to boost private investment and redevelopment in the metro influence zones. The resulting gains in land and property value enhance the revenue-generating sources for the city governments.

Oregon Metro in the United States offers insights into leveraging the synergies of TOD and LVC. The Tri-County Metropolitan Transportation District of Oregon (TriMet), the implementing agency of the metro, has been vested with powers to levy taxes within its service area.[45] In the two decades since its inception, the metro's TOD mechanism has made cumulative investments of over US$35 million through strategic investments and incentivising PPPs for housing and commercial development.[46] Since 1998, Oregon Metro's investments in TOD mechanisms have raised US$1.19 billion in residential and commercial real estate served by high-quality transportation.

On the other hand, China's Shenzhen is an example of how integrated metro rail transit and land-use plans have overcome the mismatch between real estate development and market demand.[47] Hong Kong,[48] Jakarta (Indonesia),[49] Manila (Philippines),[50] Bangkok (Thailand),[51] Tokyo (Japan),[52]

and Singapore[53] are the other success stories of LVC for urban transit, which provide crucial lessons to India as it emerges as one of the most prominent metro destinations globally.

Policy Environment for LVC in India

While urban transportation has long been a challenge in India, the concept of 'planning' for its provision was largely absent from policy discussions until the rollout of the reforms-led Jawaharlal Nehru National Urban Renewal Mission (JnNURM) in 2005.[54] Subsequently, the 2006 National Urban Transport Policy (NUTP) attempted to provide a roadmap for the states and urban local bodies (ULBs) to integrate mass transit in their long-term strategic development and land-use plans.[55] However, even the NUTP made no concrete recommendations for integrating LVC in transport planning. It broadly mentioned the need to levy dedicated taxes to supplement petrol and diesel taxes, betterment levy on landowners, and even an employment tax on employers. It also recommended commercially utilising the land resources with public transport service providers to augment revenue sources.

In 2017, as numerous Indian cities sought to construct metro rail projects as perceived long-term solutions to transport woes, the MoHUA established two critical policy guidelines—the Value Capture Finance (VCF) Policy Framework and the National TOD Policy. Thus, within the scope of urban transport planning in India, both TOD (as a concept that integrates land-use and transport planning to develop sustainable urban growth centres) and LVC (as a concept to leverage the enhanced land value as an additional resource for financing infrastructure projects, and as a subset of TOD) are still in their infancy.

The TOD policy envisions a major shift from a private vehicle-dependent city to public transport-oriented development by promoting affordable, comfortable, and universally-accessible multimodal public transport. The objective is to encourage walking and cycling and other forms of non-motorised transport (NMT) and eventually create liveable and affordable localities that are compact and walkable.[56] The policy document also includes a chapter on LVC as an effective tool to make TOD financially viable through additional land value tax or a one-time betterment levy, development charges or impact fee, and transfer of development rights.

The VCF Framework's primary focus is to present a systematic approach for states and ULBs to adopt LVC to finance urban infrastructure. The framework urges multistakeholder

involvement in financing and implementing infrastructure projects and fine-tuning and synergising existing mechanisms for ULBs to generate sustainable financial resources. It also enumerates ways to leverage LVC as an efficient instrument for revenue generation and includes a guidance note highlighting the practical aspects of the imposition of impact fees. Impact fees, commonly accepted worldwide, are a one-time charge paid by developers when land in the designated benefit or influence zone is sold or developed.

Coinciding with the announcement of the value capture framework, MoHUA notified India's Metro Rail Policy in 2017.[57] The policy, among other measures, devotes a chapter to 'enhancing revenues' through the two interdependent and harmonising aspects of TOD and value capture finance (VCF). The policy mandates that each project proposal contains a chapter on TOD with planned intermodal integration, universal accessibility, adequate walkways and pathways for NMT, stations for public bike-sharing, commensurate parking lots for cycles and personal vehicles, and proper arrangement for receiving and dispatching feeder buses at all metro stations. It also seeks firm commitment from states to adhere to the guidelines enumerated in the VCF Framework. It further mandates transferring the financial benefits accruing in the metro alignment's influence zone on TOD policies and VCF Framework to the SPV/metro rail authority. The policy mandates that all metro development proposals specify the estimated quantum of LVC benefits pumped back into the metro balance sheet.

Besides such broad mandates for raising additional revenue through LVC, the metro policy also necessitates project proposals to have concrete plans for three other ways to enhance revenues:

1. Feeder systems facilitating enhancement of the influence zone of each station to at least 5 km through last-mile connectivity provided by pedestrian walkways, NMT infrastructure, buses, and paratransit modes, including taxis and auto-rickshaws
2. Commercial/property development at stations
3. Specific ideas for improving non-farebox revenue through conventional and innovative means.

Since 2005, when urban transportation started to gain the attention of policymakers, all policies and

schemes of the Indian government have highlighted the urgent need for decentralisation and empowering the ULBs to lead and manage all aspects of urban transport planning. Empowerment of the ULBs through functional, financial and administrative decentralisation was also the primary objective of the 74th Constitutional Amendment Act in 1992.[58] However, despite its avowed objectives, the experience of the past two decades has shown that state governments, unwilling to yield their own financial and administrative powers, have only increased their control over the ULBs.[59]

The successful implementation of these urban transport policies and schemes remains incumbent on the state governments, who first have to internally carry out corresponding and enabling institutional, structural, systemic, policy and, most importantly, attitudinal reforms. This will facilitate a smooth devolution of powers to the ULBs—or the metro authority in the case of metro rail—to fully realise the potential benefits of LVC.

Impact of Metro Projects on Land Value in India's Cities

The proliferation of metro rail in India's cities has resulted in a bonanza for the real estate sector. Multiple cities have seen a 20-percent surge in land value, while residential and commercial rates have grown by up to 25 percent along the entire length of the metro rail corridors. Increased convenience and comfort and decreased commuting costs have drawn home and commercial space buyers, developers and investors to sites along the metro corridors despite the surge in land and property value. While land value has appreciated up to 5 percent annually following the commissioning of the metro lines, even the mere announcement of metro projects has pushed demand for residential and commercial properties, triggering a boom. Reports have indicated that the trend of appreciation in real estate prices as a direct result of the metro will significantly appreciate over the long run.[60] Several studies conducted by leading property marketeers and real estate consultants have portrayed the pre- and post-metro impact on land and property values in cities (see Table 4).

Table 4: Impact of metro development on land value real estate in Indian cities

City	Metro line	Length (km)	Upon project announcement (year)	Upon project commissioning (year)
Kochi	Phase 1	25	20-25% (2016)	40-50% (post-2017)
Chennai	Phase 1	45	₹ 3,600/sq ft (US$48) (2015)	₹ 7,000/sq ft (US$93) (2019)
Pune	Phase 1	31.25	38% (2016)	45% (2022)
Ahmedabad	Phase 1	21.16 km	₹ 6,000/sq ft (US$80) (2017)	₹ 10,000/sq ft (US$133) (2019)
Bangalore	Namma Metro Purple Line	18 km	10-15% (2009)	30-55% (2011)
Jaipur	Phase 1A	9.63 km	5-10% (2010)	15-25% (2015)
Hyderabad	Phase 1 – Corridor 1	29 km	₹ 2,433/sq ft (US$32) (2012)	₹ 6,753/sq ft (US$90) (2017)

Source: Magicbricks,[60] CommonFloor,[61] Nagpur Metro Rail,[62] The Metro Rail Guy,[63] Business Today[64]

According to a 2021 study by real estate services firm JLL India, metro corridors have contributed to up to a 20 percent increase in land prices, especially within the initial 500 metres of their influence zones.[66] Commercial property prices within this distance have experienced a sharp growth of up to 25 percent due to reduced commute costs and improved job opportunities. For instance, from 2015 to 2021, South Delhi witnessed a 20 percent rise in residential property rates. In contrast, Hyderabad's micro-markets of Corridors 1 and 2 have reflected an increase in prices by 20 percent in less than four years (2018 to the first quarter of 2021). In Chennai, properties closer to the metro corridor have registered an increase of about 35 percent. In addition, several locations close to the central business district (CBD) and secondary business district (SBD) in Bengaluru witnessed a 10 percent rise in prices soon after the commissioning of the metro line. The report forecasts that across India, depending on the location and land use, the overall property prices are likely to surge by at least 15 percent as new metro projects become operational.

Other reports have also revealed the direct impact of the metro on rentals within CBDs and IT parks. For example, at the DLF Cyber City in Gurugram, seamless metro connectivity has increased property rental prices from US$0.9 per sq ft in 2012-16 to US$1.75 per sq ft in 2019.[67] Similarly, the influence zone around the under-construction Whitefield metro line in Bengaluru has witnessed a steep increase in mixed-use real estate development.

These findings suggest that India's urban population is willing to pay more for the convenience of property projects around the metro vicinity. The immediate socioeconomic benefits emerging from a metro corridor have contributed to the increase in land value, land-use change, and densification along the corridor. As a mass transit system, the metro has also contributed to easing traffic congestion on the streets.

However, in 2022, the lingering economic slowdown because of the COVID-19 pandemic and the uncertain economic fallout of the ongoing Ukraine war and subsequent global sanctions on Russia may create hurdles to metro development in India in new ways. It is also worth noting that while residential property developers can opt to increase their prices overnight following the announcement of a metro project, the real LVC benefits flow to the commercial and office space developers only once the metro line becomes operational. While this will not impact LVC over the long term, the resultant uncertainty and inflationary trends will dampen real estate enthusiasm until the world and India, in particular, realises the damage caused to the global economic sentiments.

Metro and LVC: Potential versus Realisation

The frenzy of developing metro rail transit systems witnessed across many cities in India has contributed to socioeconomic growth. The long-term increase in land value, booming real estate and property markets along the metro corridors' influence zones, overall improvement in quality of life, reduced costs of commute and reduced commute time, and enhanced job opportunities have led governments to realise the importance of the much-needed but often-ignored concepts of TOD. However, detailed studies on the adoption of LVC to augment the financial strength and non-farebox revenues of the implementing agencies have revealed mixed results. Many metro projects, especially those sanctioned before the release of the Metro Rail Policy and the VCF Framework in 2017, have either missed

the point or made poor attempts at realising the LVC benefits. This report evaluates the LVC experience of two Indian cities, Bengaluru and Mumbai, that have been selected for the following reasons:

- LVC was ignored in the planning of Mumbai Metro One, which began operations in 2014. However, the metro authority has made it an integral part of the rollout of all the other metro rail corridors expected to significantly improve living conditions and reduce the load on the severely overburdened suburban railway, which ferries eight million passengers daily. While two metro lines were inaugurated on 2 April 2022, eight others, spreading the metro rail network to 337 km, are expected to be launched in 2024-2026.[68] Learning from the mistakes of Mumbai Metro One, the government has proposed to incorporate multiple LVC tools for all the upcoming corridors.

- Bengaluru's 55.6-km metro corridor is India's third-largest operational metro rail network. Phase 2, expected to be completed in 2024-25, will add 115.85 km to this network. The metro authority has leveraged two fee-based LVC tools besides earning non-farebox revenue through commercial exploitation of its physical assets, much like Delhi. Some of the interventions also provide learnings on what other cities must be cognisant of in their quest to maximise LVC gains.

• **Bengaluru**

Bengaluru's Namma Metro, operated by the Bangalore Metro Rail Corporation Limited (BMRCL), an SPV established as a joint venture by the Indian government and Karnatak state government, is India's third-largest operational metro network. Spanning 42 km, the metro project's Phase 1 began staggered operations between 2011 and 2017. At the end of Phase 3, the network will cover a route length of 277 km.

Of the total Phase 1 project cost of INR 138.45 billion (US$1.846 billion), INR 81.34 billion (US$1.085 billion) was funded by the central and state governments through equity contribution and subordinate debt. Senior term debt from multilateral/ foreign funding agencies, banks, and financial institutions was approved to raise the remaining INR 57.1 billion (US$761 million). As of 31 March 2021, BMRCL raised INR 50.46 billion (US$673 million), leaving scope to raise the balance INR 6.64 billion (US$89 million) through senior term debt.[69] The company also plans to bridge an additional

funding gap of INR 1.82 billion (US$24 million) per the initial funding pattern. BMRCL is exploring options to meet these shortfalls from new loans or through the debt route by issuing privately placed secure non-convertible debentures or bonds (see Table 5).

Table 5: Cumulative funding of Namma Metro Phase 1 (INR billion)

Funding pattern	State	Government of India	Senior debt	Total
Equity	19.83	19.83	-	39.66
Subordinate debt	30.77	10.90	-	41.67
Japan International Cooperation Agency	-	-	32.08	32.08
Agence Française de Développement	-	-	8.73	8.73
Housing and Urban Development Corporation Ltd	-	-	6.50	6.50
Karnataka Urban Infrastructure Development and Finance Corporation	-	-	1.47	1.47
Non-convertible Debentures (Bond series 1)	-	-	3.00	3.00
Balance to be raised	-	-	6.64	6.64
Total	50.60	30.73	58.42	139.75

Source: BMRCL Annual Report 2020-21[70]

With excellent connectivity along its east-west and north-south corridors, the metro has drastically reduced travel time (from hours via road to about 30-45 minutes). Phase 1 continues to log a daily ridership of around 400,000. Notably, though it achieved an operational surplus of INR 540 million (US$7.2 million) in 2019-20, this was spent on servicing debt and other expenses.[71] According to reports, BMRCL will take two decades to repay

its debt to foreign funding agencies and another two decades to service its loans from the state and central governments. Currently, the operator pays INR 1.30 billion (US$17 million) per annum as an interest amount for the external and internal lenders for Phase 1.[72]

While it is common for public transport providers to struggle to break even and rare to register profits given the socially obligatory nature of their service, Bengaluru's metro has resulted in rich dividends for the city's economic landscape. The fare structure includes tokens—best used for single one-way commutes—priced anywhere between INR 10 (US$0.13) and INR 60 (US$0.8).[73] BMRCL also offers group tickets for a minimum of 25 passengers travelling between the same stations at a 10-percent discount over the token fares. It also provides the rechargeable 'Varshik' smart cards at 5 percent off on the token fare, but their use is still limited as other modes of transport, especially the city buses, are yet to upgrade their ticketing systems for common mobility across transport modes. Passenger fares contribute up to 79 percent of BMRCL's operational revenue, while it earns only nine percent from other non-farebox sources, including rental and advertisement income.[74]

The seamless connectivity provided by metro lines in Bengaluru has transformed several lesser-developed inner-city and underdeveloped peripheral areas into commercial zones. Peripheral areas also witnessed unprecedented development as new residential hubs.[75] This transformation presents a unique opportunity for LVC for the mutual benefit of both the TOD communities and the government. The BMRCL is now actively exploring LVC mechanisms to augment its coffers.

To encourage TOD, BMRCL has adopted two fee-based LVC tools—betterment levy and premium floor area ratio (FAR).[76] The betterment levy is a one-time upfront fee charged on the direct metro-related land value gains within 150 metres on either side of the corridor. On the other hand, the FAR is a one-time tax collected for sanctioning an extra FAR of four to property developers for construction, thereby increasing densities and opportunities in the metro's immediate influence zone.

Cumulatively, LVC tools, including premium FAR, betterment levy, naming and advertising rights, asset and airspace commercialisation, and cess on approval of new projects in the influence zone, are estimated to raise INR 21.31 billion (US$284 million). According to BMRCL best-case

scenario estimates, the sale of premium FAR on the proposed Outer Ring Road line can potentially raise INR 11.43 billion (US$152 million).[77] The BMRCL's 2019 TOD policy has sought to levy a cess of 10 percent on residential buildings and 20 percent on commercial buildings on the premium FAR.[78] It has recommended revenue sharing among the BMRCL, Bruhat Bengaluru Mahanagara Palike (BBMP), the Bangalore Water Supply and Sewerage Board (BWSSB), and Bangalore Development Authority (BDA) in the ratio of 60 percent, 20 percent, 10 percent and 10 percent, respectively. The proposed betterment levy would be a one-time upfront payment charged at 1.5 percent of the overall value of a commercial built-up area within one km of the metro corridor once the project is approved. The TOD policy has also recommended increasing the metro influence zone to 500 metres to multiply the returns from premium FAR and increase the TOD reach (see Table 6).

However, developers fear the proposed premium FAR will be detrimental to the city's real estate market. While the premium FAR offers half the guidance value (or market value) of the proposed built-up area, transferable development rights (TDRs) offer twice the price of the land guidance value. So while the formula to evaluate the TDR versus premium FAR gains is still being debated, real estate developers have cautioned that the proposal would create an "artificial market" and lead to an "inflation in property costs".[79]

Table 6: LVC tools proposed by Bengaluru's TOD policy

Proposed LVC tool	Description	Status
Levy of surcharge	Additional surcharge at 5 percent of the property's market value for developments within the BDA area under Section 18A of the Karnataka Town and Country Planning Act	Mired in legal ambiguity
	Proceeds used to establish a Metro Infrastructure Fund to be shared by BMRCL (65%), BWSSB (20%), and BDA (15%)	Pending approval
	To be shared between BMRCL and allied agencies for metro development and other civic amenities and utilities	
Cess on premium FAR	Extra premium FAR of four to all developments within 500 metres on either side of the metro corridor for Phases 1 and 2	Modified proposal awaiting state government approval
	Cess of 10% on residential and 20% on commercial properties on premium FAR utilised	
	Revenue sharing between BMRCL (60%), BBMP (20%), and BWSSB and BDA (10% each)	
	To be used to repay BMRCL's loans and fund civic amenities and infrastructure for the densification and development of station areas	
TDR	TDR for issuance by BMRCL against land acquired for metro development	Discussion stage
PPP	BMRCL to initiate PPP for rolling stock and operation and management for two new lines in Phase 2	Discussion stage
Carbon credits	BMRCL to earn tradable carbon credits for the projects to finance operational expenditure	Discussion stage
Differential fares	BMRCL to explore surge pricing wherever feasible and charge higher fares during peak hours for trips between stipulated stations and increase farebox revenue	Discussion stage

Source: Bengaluru TOD Policy[80]

Although most aspects of the BMRCL TOD policy failed to go beyond the discussion stage, the Karnataka government's Directorate of Land Transport introduced a revised TOD policy in November 2021.[81] It proposes to increase the share of public transport in Bengaluru from the current 48 percent to 70 percent by 2031 by expanding mass transit systems, in line with the city's estimated population growth. The revised policy has also yet to progress beyond the discussion stage.

Besides these proposals for leveraging LVC, the BMRCL has co-developed five metro stations through the PPP model. It has also raised non-farebox revenue through rentals and licencing fees by leasing station floor space to retail and commercial ventures, including parking lots. In 2017, the BMRCL raised INR 2.51 billion (US$33 million) by entering into a long-term lease agreement with the Swedish furniture giant IKEA for 13 acres of land at the Nagasandra metro station.[82]

However, these efforts have had limited results, given the lack of supporting policies and the freedom to implement innovative practices. As a result, BMRCL has not exploited the full potential of capturing the land value.

- **Mumbai**

Although Mumbai's metro rail plans received in-principle approvals in 2006, the progress of the metro network has been woefully slow. Several other cities, which conceptualised the metro much later, have progressed far beyond India's business capital, with many already having operational corridors.

The Metropolitan Region Development Authority (MMRDA), tasked with regional planning, promoting new growth centres, financing and implementing strategic and infrastructure development in the Mumbai Metropolitan Region (MMR), is implementing Mumbai's metro system. Mumbai Metro One, the 11.40-km metro line connecting the western suburb of Andheri to Ghatkopar in the east, was inaugurated in June 2014. With the suburban railway only providing linear south-north connectivity and poor arterial road networks failing to provide the much-needed reliable east-west connectivity, the metro line reduced the travel time from 90-120 minutes to 21 minutes.[83] The line is operated under a PPP arrangement by the Mumbai Metro One Private Limited (MMOPL), an SPV incorporated jointly by the MMRDA, Reliance Infrastructure, and Veolia Transport France with a 35-year concession

period. MMOPL, structured as a BOOT model PPP[l], is mandated with the design, finance, construction, operations, maintenance, and eventual system transfer to the state government at the end of the concession period.[84]

The construction of the line began in 2007. Still, the project suffered from considerable cost and time overruns owing to factors such as the right of way, changes in design, and delayed safety and other technical approvals from the Indian Railways. At the time of completion, the delay of two years resulted in the project cost increasing to INR 43.21 billion (US$576 million) from the estimated INR 23.56 billion (US$314 million).[85] The project had a viability gap funding provision of INR 6.5 billion (US$87 million).

Land value studies carried out independently by realty consultants during the construction phase of the Mumbai Metro One had indicated that the metro would prove to be a "gamechanger" for Mumbai's suburban northeastern fringe.[86] The metro line, connecting two city regions unserved by the suburban railway, was believed to "single-handedly account for at least 22 percent variation in land value" near both sides of the corridor. The increase would be much higher if considered in unison with other infrastructure development projects around the metro corridor, such as the Chembur-Wadala Monorail.

Despite this anticipated windfall in land values in the metro line's influence zone, the PPP for Mumbai Metro One hinged solely on the projected ridership based on a traffic demand model. The government failed to factor into the

---

[l] In a build-own-operate-transfer (BOOT) model PPP, the public-sector partner enters into a long-term contract with a private developer (typically a large corporation or consortium of businesses with proven expertise) to design and implement a public project. The public-sector partner usually partially funds the project or passes on benefits, such as tax exemptions to the private partner, while the latter assumes all risks associated with planning, constructing, operating, and maintaining the project for a specified time period. During the 'own and operate' phase of the contract, the developer charges users of the built infrastructure a fee to realise a profit; for example, tolls paid at bridges and flyovers. At the end of the contract period, the private partner transfers ownership to the public sector partner, according to the contract terms.

planning process the impact of the metro line on land value and the corresponding revenue generation to enhance the operator's earnings. The traffic demand model estimated that the metro would attract ridership of 665,000 per day by 2021 and 883,000 per day by 2031.[87] Contrary to this projection, since its inauguration in 2014, the ridership has averaged 450,000 per day.[88]

With no alternate sources of income besides the limited revenue from rentals of commercial space within station areas and advertising, factors such as an overdependence on farebox revenues, high operations costs, and high loan interest rates started to pinch the MMOPL's coffers in the early days of operation. In 2015, the fare fixation committee (FFC) set up by the Indian government fixed a fare band of INR 10 to INR 110 (US$0.13 to US$1.46) for MMOPL.[89] Within one year of beginning operations, the FFC recommended a fare hike in five slabs at INR 10, INR 20, INR 25, INR 35, and INR 45, as against the then prevailing slabs of INR 20 for 2-5 km, INR 20 for 5-8 km, and INR 40 for commutes beyond 8 km.[90] The FFC once again completely ignored the potential gains through LVC. However, following litigation, the Bombay High Court stayed its implementation in December 2017 and ordered the formation of a new FFC to decide on the fare structure.[91] The new FFC was constituted only in 2019 and is yet to decide on a fare revision, leaving the MMOPL to continue suffering a daily loss of INR 9 million (US$120,000).[92]

Ironically, Mumbai is one of the few Indian cities with legislative provisions for LVC ingrained in its civic and town planning laws. The Maharashtra Regional and Town Planning Act, 1966, entitles the MCGM to recover development charges by selling additional floor space index upon any change in land use. The MCGM is also empowered by the Mumbai Municipal Corporation Act, 1888, to collect property tax from all city land and buildings and recover betterment fees on any windfall gain that may accrue from public investments and improvement projects. On the other hand, the MMRDA Act of 1974 empowers the metropolitan planning and development authority to levy betterment charges on any windfall gains—of not more than 50 percent of the windfall gain—to private landowners resulting from an MMRDA development project. However, it failed to levy betterment charges on the metro line's influence zone as it could not empirically evaluate the metro's impact on its adjoining land value.[93]

A 2018 study using a hedonic price model to assess Mumbai Metro One's impact on land value in its catchment area revealed that properties located within 1-2 km from the metro stations recorded a gain of 14 percent, resulting in a new revenue source to the tune of US$179 million[m.94] The findings illustrated how Mumbai Metro One had directly contributed to increased land value beyond the traditional 500-metre influence zone. Had the MMRDA used its legislative powers to capture this substantial increase in land value, the Mumbai Metro One would not have had to resort to fare hikes as an existential need.

Another study noted that in 2000, office stock in the CBD, mainly restricted to around Nariman Point in South Mumbai, was up to 14 million sq ft, almost 72 percent of Mumbai's total stock. In contrast, the SBD's share in the metro's influence area, the western business district, was just 8 percent. Within two years of the state approval of the metro, the western SBD's office stock rose to 23 percent. Within one year of the commencement of the construction, it reached 33 percent of the total and grew to 35 percent in 2014, when the metro line began operations. Within no time, the western SBD office stock had grown to 40 million sq ft, spreading to micro-markets in Andheri, Jogeshwari, Goregaon, and Malad, while the share of the CBD shrunk to 13 percent.[95] In the three years between the project announcement and construction commencement, the Andheri East residential property appreciated by 185 percent, growing to INR 8,000 (US$106.66) per sq ft from INR 2,800 (US$37.33) per sq ft. During the construction phase and inauguration of the metro operations from 2007-08 to 2014, residential real estate appreciated by a further 94 percent to INR 15,500 (US$206.66) per sq ft. The study has estimated a similar impact on land values in the influence zones of the upcoming metro corridors in Mumbai.[96]

But Mumbai Metro One is only the tip of the iceberg, considering MMRDA's extensive metro planning across the metropolitan region, much beyond the boundaries of Greater Mumbai. The MMR is currently working on 14 other

---

[m] At 2017 exchange rates.

metro corridors, of which line 3 is being implemented by the Mumbai Metro Rail Corporation Ltd., a joint venture of the Maharashtra government and the Indian government on a 50:50 sharing basis, and all others being developed directly by MMRDA. Estimated to cost INR 1.50 trillion (US$20 billion), the corridors will cover a route length of 300 km within the MMR.[97] The MMRDA has incorporated a range of tax- and land-based LVC tools in the design of all forthcoming lines. While the 18.5-km Dahisar-DN Nagar Metro 2A and the 16.5-km Dahisar East-Andheri East Metro 7 began operations on 2 April 2022, work on many more is in an advanced stage. Running parallel to the Western Express Highway and the Linking Road, these two metro lines are expected to ferry one million commuters daily.

Will Stakeholders be Ready to Pay?

Despite LVC gaining the attention of policymakers, questions remain about its effective implementation. The multiplicity of jurisdictions that lack coordination, the absence of the required empowerment to the metro authority, the lack of an overarching and empowered unified transport authority, suspicion over the accuracy of measurement of the perceived land value appreciation, and other factors continue to cast doubts on the successful implementation of LVC. Leveraging land value as a finance tool for infrastructure projects has also raised concerns over the misuse of land resources for commercial gains, which might accrue only to the powerful private builder lobby.[98] For example, BMRCL's Mantri Square Sampige Road station was constructed on a 5.04 acre plot acquired in the city's prime area for "industrial use" with suggestive overtones of "public purpose". With 32-storeyed residential towers and a 27-storeyed commercial building, the station complex was developed under a PPP between BMRCL and the private developer, loosely designed on Hong Kong's rail-plus-property (R+P) model.[n,99] Unlike the Hong Kong model, where the metro authority owns the development, the Mantri Square station developer invested capital for

[n] Hong Kong's unique rail-plus-property (R+P) model creates an integrated community, providing housing, shopping, office, and leisure facilities under one roof, with easy access to public transport. The R+P model requires no direct government financing. Instead, the government receives a significant land premium and enhanced equity value through majority shareholding in the Metro Transit Rail Corporation.

the entire station complex in return for a 99-year land lease, which was valued at INR 3 billion, with an assured bounty from the sale proceeds owing to the development's walkable connectivity with the station. But the private developer reportedly reaped disproportionate benefits from LVC, leaving a pittance for the metro rail authority.[100] Studies of the project have also highlighted how gains from public infrastructure were diverted to favour private developers in alleged violation of local planning laws, with the state government ignoring genuine concerns in the PPP formulation and glossing over suspected illegalities in the transfer of land to private players.[101]

These factors combine to raise questions on the ability of the government to implement fair and accurate LVC and the willingness of the stakeholders in the influence zone to share the windfall gains in their land value and pay additional levies for the comfort and convenience that the public infrastructure provides. In addition, the trust deficit among the people in the government and private developers may pose a bigger challenge.

Yet, a study of the Bengaluru metro provides some exciting insights into the willingness to pay. Deploying a cross-sectional panel data hedonic price model, the study analysed the value variation of 160,000 apartments over 2012-16 and studied 314,000 apartments in 2016. The study revealed that the Namma Metro has led to citywide land value appreciation. A 'before' and 'after' comparison from the commencement of the metro rail operations indicated a price uplift of 4.5 percent across the city and showed a significant mushrooming of residences, companies, services, and industries in close proximity, resulting in cost reductions and efficiency gains. This localised agglomeration economy triggered by the metro led to people being willing to pay US$306 million for metro rail accessibility.[102]

This finding has far-reaching policy implications in the Indian context. Firstly, as the core of the urban fabric, the transportation sector impacts all urban activities and has a citywide impact in sculpting demand beyond its perceived influence zone. Secondly, with traffic congestion blocking potential economic growth, the metro significantly improves connectivity and accessibility and spurs newer avenues of economic growth. For India's developing cities, the metro means more significant agglomeration benefits brought by bigger accessibility gains.[103] Most large cities seem to have implemented this learning in the rollout of their metro works (see Table 7).

Table 7: LVC tools being considered for metro rail development in cities

City	Land Value Tax	Land-use change fee	Additional Stamp Duty	TDR/ Additional FAR/Incentive Floor Space Index	Development charge/ Impact fee/ Betterment Levy	Vacant land tax
Mumbai	Y	Y	Y	Y	Y	-
Pune	-	Y	Y	Y	Y	Y
Nagpur	-	Y	Y	Y	Y	-
Bengaluru	-	Y	-	Y	-	-
Chennai	Y	Y	-	Y	Y	Y
Kochi	-	-	-	Y	-	-
Ahmedabad	-	Y	-	Y	Y	-
Bhopal	Y	-	Y	Y	Y	-
Bhubaneswar	-	Y	-	Y	-	Y
Lucknow	-	Y	-	Y	Y	Y
Delhi	-	Y	Y	Y	Y	-

Source: National Institute of Urban Affairs[104] and various others

i) Land Value Tax (LVT) is different from the municipal property taxes. Successfully used in several western economies, it is a new concept for India. LVT as an LVC tool in urban areas can provide additional sources of revenue to the government for investment in public infrastructure projects. LVT also helps in ending specuative land hoarding and reduce prices for the buyer.[105] While a few metro athorities have incorporated the LVT concept in their TOD-LVC planning, implementation will depend on political backing and legislative approval.

ii) Land-use change fee is a one-time levy. States in India have earmarked different land-use conversion fees and they also tend to vary in different districts and even in areas within districts. For example, New Delhi has a conversation fee ranges from INR 14,328 to INR 24,777 per sq mt. State governments may also levy these fees as a percentage of the land value. In Karnataka, land-use change certification is facilitated online, and the fee conversion fee is also recovered online. Section 199 of the Greater Hyderabad Municipal Corporation Act, 1955 also empowers the municipal corporation to levy 0.05 percent of land value capital as VLT. However, other cities have faced legal hurdles. For example, the Supreme Court of India has stripped New Delhi Municipal Council (NDMC) of its powers to levy VLT under the NDMC (Determination of Annual Rent) Bye-laws, 2009.[106]

iii) ULBs governing large cities in India have started levying Vacant Land Tax (VLT) on vacant land and plots in prime areas to prevent wasteful use of expensive and scarce land resources. Since 2009, the Greater Chennai Municipal Corporation (GCMC) charges VLT of 50 paise per sq ft from vacant landowners in inner city areas and INR 1.60 from vacant land lying close to the main city bus routes.[107]

Yet, the Hyderabad metro rail, with an operational Phase 1 network of 71 km built at the cost of INR 165.11 billion (US$2.20 billion)[108] and an under-construction Phase 2 covering 58 km, has restricted itself solely to station area development and advertisement tax as the key LVC tools to generate non-farebox revenue. Accordingly, it exploits joint commercial development in parking and circulation areas from six million sq ft at 25 stations to earn lease and rental income. It also has shopping malls at Panjagutta, Hi-tech City, and Erra Manzil under three-year sub-licence arrangements. The Park Hyderabad app offers paid parking for two- and four-wheelers at all metro rail stations.[109] The company has also exploited 12.5 million sq ft at its depots at Miyapur, Falaknuma, and Nagole by planning joint development of IT/IT enabled services offices, hospitals, high street retail, leisure and entertainment, hostels and service apartments, and other 'built to suit' spaces.[110]

The project implemented under a concession agreement with the state government and L&T was claimed to be the "world's largest PPP" model. The Hyderabad Metro Rail is supported by a consortium of 10 banks led by the State Bank of India, incurring a debt burden of INR 110 billion (US$1.46 billion) on the metro rail company.[111]

Challenges to LVC

For any LVC policy to realise tangible results, it is incumbent on the government at the state and city levels to work with an empowered implementing agency by adopting a multistakeholder and participatory approach. Land-financing mechanisms through TOD must not compromise on equity and fairness to all income classes and must not create more avenues for builder lobby-favouring markets. But the government must first create appropriate institutional frameworks to prioritise, facilitate, and coordinate proper land use transport integration to finance TOD. Revenue earned and reinvested can improve the metro authority's financial health, strengthening the PPPs and preventing situations faced by Mumbai Metro One when the government partner in the PPP resorted to litigation against the proposed fare hike.

Locational: Prevalent income disparities, job opportunities, differences in the size of land parcels and civic amenities in the various pockets also create hurdles. The inadequacy or absence of primary physical and social infrastructure and services and poor integration of last-mile multimodal connectivity in the metro design keep investors away from peripheral lands. Extracting the benefits from premium FAR becomes difficult from the fragmented and small-

sized plots in the core areas, further curtailed by zoning regulations. The restrictions on additional FAR for land lying beyond a specific distance from the rail corridor must also be implemented dynamically, considering the locational characteristics.

Planning and regulations: Typically, cities lack institutional structures and integrated planning between the different state agencies involved with service delivery. Each agency works, plans, executes and manages in a silo, resulting in diffused decision-making. Primarily, city planning is governed by the ULB, which does not have any direct say in preparing transportation plans. The state has not included a single Indian ULB in the metro rail plans for the city it governs. While many cities have attempted to create CMPs, the metro rail corridors are coming up without the crucial micro-planning for the metro rail influence zones.

Concerns also remain regarding properly integrating the draft CMP and the city master plans and vice versa. For example, metro rail development by BMRCL has reportedly neither integrated the Bengaluru CMP (2019) nor the development plans of other civic agencies in its design. The lack of integration of metro rail projects with other city planning agencies is believed to have hampered the proper utilisation of the metro rail system and left the long-term mobility aspects unaddressed. Experts have also termed Bengaluru's CMP a "paper exercise" to access central funds for the expensive metro rail system.[112] On the other hand, Mumbai's upcoming metro rail lines have benefited from the city's CMP and the development plan (DP) being in sync. The MCGM prepared the CMP in 2016, two years before the state government's approval of the city's DP. The significant delay in the construction of new metro rail lines has, in this case, given the planners an opportunity to integrate its design into both the CMP and DP. City planners are said to have taken due care to keep the dynamic in mind for the upcoming metro rail lines, the proposed Mumbai Trans Harbour Link, and the coastal road. In case of any future zone alteration requirement, the CMP will prevail over the long-term DP.

Cities have also not established UMTAs with overarching empowerment to plan and supervise multimodal transport development. Even the metro authorities have failed to incorporate influence zone planning along the corridors and accurately estimate the perceived windfall gains in land value in the influence zones. As a result, the execution of TOD has failed to factor in the full benefits of LVC.

Executional: Nearly all big infrastructure development projects in India have traditionally suffered from time and cost overruns owing to complexities emerging from land acquisition, eviction of slums from large land parcels, long-drawn litigations, and delays in getting approvals from central agencies.[113,114,115] In Mumbai's experience, nearly all projects, including the World Bank-funded Mumbai Urban Transport Projects, the Bandra-Worli Sealink, and the metros have resulted in high costs to the public exchequer because of procedural and legal delays. Nearly all cities rolling out metro projects have also failed to meet extended deadlines leading to enormous cost escalation. The perceived gains through LVC diminish as the capital expenditure increases because of time overruns.

LVC Lessons from Global Cities

Several cities in Asia, particularly Hong Kong and Shenzhen (China), have reaped immense benefits from LVC for their metro projects.

Hong Kong: Few public transport services return a profit. Hong Kong is an outlier, making net profits of more than HKD 10 billion (US$1.43 billion) year-on-year since 2011. Hong Kong's Mass Transit Railway Corporation (MTRC) runs a R+P model that has successfully leveraged gains from LVC to ensure that the transport company remains self-financing, unlike most of its counterparts across the world, which are perennially loss-making and survive on government subsidies.

While well-established transporters such as the New York City subway and Transport for London perform poorly, how has the MTRC remained profitable despite comparable fares (that contribute 170 percent of the system's operating costs)?[116] The MTRC's R+P model provides answers. The R+P model is based on a simple mantra—make the best multi-use of public infrastructure and the scarce urban space it stands on to provide high-quality housing with easy access to transport modes and maximise revenues from rental and sales. MTRC gets land and development rights from the government, the majority shareholder in the venture, at the price before the metro is constructed. As the line is built, MTRC invites private developers to build residential and commercial complexes above and within its station periphery, earning capital for the system's operations and management through its share of the sale proceeds or rental incomes. However, not all MTRC development is at greenfield sites. For example, it has successfully retrofitted the existing Fo Tan depot to suit the R+P model.[117]

Since its implementation in 1980, the R+P model has been expanded across Hong Kong, and MTRC today manages 47 developments above its 93 stations and depots, generating revenue of HKD 5 billion (US$700 million) through property management and rental income. A new township with a population of 380,000 was established from revenues earned by the Tseung Kwan O line extension.

However, of late, MTRC has also faced criticism for profit maximisation by building housing and amenities only for the high-income sections, creating a severe shortage of affordable housing. This has also become a politically sensitive issue. Anthony Cheung Bing-Leung, Hong Kong's former transport minister, stated that the government must curtail the exclusive rights given to MTRC to build housing and commercial amenities on its properties.[118] In 2018, the government forced MTRC to reallocate 30 percent of its new residential developments to public housing. This pressure has resulted in the development of two new sites at Siu Ho Wan and Tuen Mun, where the MTRC's first public housing development will create 22,000 flats.[119]

Shenzhen: Shenzhen is the first city in China to emulate Hong Kong's R+P model in its metro development. Shenzhen's model forges partnerships between the public sector, transporters, and developers to plan and finance metro lines and the surrounding real estate developments.

Using municipal grants and loans to initiate the first phase of the metro project, Shenzhen was forced to adopt innovative financing mechanisms when project costs shot up tenfold during expansion. It implemented variable risk- and profit-sharing tools that helped a beneficial spread of gains and expenses among the stakeholders. The outcome was a win-win situation as housing value within 500 metres of the metro increased by 23 percent. While residents gain from increased accessibility and enhanced opportunities, the developers who have invested in the R+P model gain from increased property values. At the same time, the metro company gains by reducing its dependency on public investments and facilitating urban planning and social and economic growth.[120]

In the early days of experimenting with the R+P model, the Shenzhen Metro Group (SMG) found itself grappling with issues beyond its expertise and was reluctant to expand the business portfolio and take on additional development costs and market risks. However, the government forced it to adopt the R+P model using a carrot-and-stick policy with three tactical interventions.[121]

1. The government lowered its capital investment in SMG to 50 percent from 70 percent, forcing it to seek other funding sources
2. The land was transferred to SMG through auctions with special terms restricting the number and qualifications of bidders, enabling the group to acquire land at prices lower than in an open-market auction
3. The land concession fees paid by SMG was returned as capital investments

The government further supported institutional and procedural changes for the development of Shenzhen Line 4 by MTR Shenzhen, a local project agency tasked with financing, construction, operation, and extension. This process helped SMG acquire land use rights for free and keep a significant share in the future value appreciation to improve its financial health. SMG was also allowed to engage developers through a build-transfer PPP, offsetting the construction risks.

Over the years, Shenzhen has seen several bold innovations and aligned the visions of different stakeholders, integrated rail transit and land use planning with financial planning and introduced flexible regulatory zoning to implement TOD and maximise LVC gains. In addition, its special powers as a special economic zone (SEZ) conceptualised since 1980 have also helped the city implement development projects that are difficult to emulate in other parts of China owing to more stringent city laws and regulations.

Since the turn of the century, Shenzhen's metro has moved away from dependency on public investment to seek newer modes of revenue through land equity investment. The willingness of government and project agencies to break away from the conventional practice and bring transparency in their dealings with stakeholders has created an enabling environment. The city has nurtured PPPs using the principle of capturing and creating land value, allowing the public sector to invest in social inclusion and accessibility through mass transit systems while incentivising the private sector to invest in quality development. It has created land value and shared and reinvested it, creating a virtuous cycle for urban infrastructure development.[122]

LVC in Metro Development: The Way Forward for India

Upcoming metro projects in India can substantially increase their LVC potential if the government makes it conducive for appropriate regulations and incentives to prioritise TOD-based development in all city master plans.

Reinvesting LVC revenues into the metro system and its expansion can strengthen the joint venture/SPV model funded by the governments at the central and state levels and supplement efforts for forging mutually-beneficial PPPs, which can spur development-based LVC mechanisms. The experience of Mumbai, Bengaluru and several other cities highlight the following essential tasks the governments must urgently take up to foster a conducive environment for maximising LVC returns for metro projects.

Institutional, policy and regulatory frameworks: Government policies and schemes, from the JnNURM and NUTP to the Metro Policy, have repeatedly highlighted the importance of CMPs and UMTAs to integrate land-use planning and transport development. CMPs and UMTAs are the prerequisites for metro agencies to prioritise their roles in planning processes and focus on TOD. However, this mandate has largely remained unfulfilled. States must prioritise establishing financially- and legally-empowered UMTAs through legislation as overarching bodies to facilitate land use and transport planning integration. Currently, as both these functions are vested in different agencies, the centrality of mass transport in land development is ignored, resulting in fragmented decision-making and diffused approaches to TOD.

For example, in Mumbai, the MCGM is tasked with the CMP and DP for the city, but it has no say over the planning and execution of the metro lines by the MMRDA. Meanwhile, except for Mumbai Metro One and Line 3, all other metro line operations are vested in the Maha Mumbai Metro Operation Corporation Ltd., tasked with operating and managing all metro rail corridors in the metropolitan region. In Bengaluru, planning and execution of public infrastructure, civic services, and metro operations are divided among the BBPM, BDA, BWSSB, BMRCL, and other state agencies managing diverse aspects of city governance.

An empowered UMTA must also adopt a participatory approach and prioritise community engagement to spread awareness of the potential windfall gains in land value through increased access to help the metro agencies secure the much-needed public support for LVC levies. Furthermore, instead of merely reiterating the concept of UMTAs in policies, the government must clarify its stand and ensure that UMTAs are institutionalised at the state level.

Several cities across India have developed long-term mobility plans following the NUTP guidelines and the increasing pressure from the centre on states to prepare CMPs as a

precondition to receiving grants. However, many CMPs have been drafted only to fulfil an obligation. In the case of the civic reforms-driven JnNURM, in a rush to receive central grants, states cooked up the necessary service benchmarks without implementing the mandated governance and systemic reforms. Many cities prepared their CMPs before they conceptualised the metro. All the CMPs must, therefore, be reviewed for their accuracy and fine-tuned to meet the pre- and post-metro impact on the mobility of each city.

Cities must follow the Bengaluru model to develop TOD policies customised to their specific needs while being mindful of possible malpractices and vested interests. The draft 2041 Delhi Development Plan has also integrated the city's 2019 TOD Policy to envisage joint ventures for station area development and multimodal transit hubs between multiple transport agencies through a proper demand assessment of the kind of services at the station and along the transit corridor. All the master plans prepared before the approval of the metro must be revised and made coherent with the resultant impact on mobility and development.

Several states have also announced the creation of an Urban Transport Fund to consolidate available resources for investment in TOD schemes. The government must develop clear guidelines and mandates for properly pooling these resources to plan and execute necessary land-use change and readjustment interventions. Only such institutional and regulatory interventions by an empowered UMTA can ensure that the CMP aligns with the city's master plan and that the ever-changing needs and TOD are prioritised. In addition, the Urban Transport Fund could provide the vital link to reinvest the fund pool generated through LVC and TOD for other transit-oriented developments.

Additionally, while metro rails are being built with substantial state and central assistance, their operations and maintenance are solely vested in the metro authority, where the private partner is in the game to make money. While the farebox revenue amounts to marginal returns, revenue generation through TOD and LVC will not suffice to meet the recurring annual financial requirements of the metro system, which are bound to grow. The bus rapid transit system (BRTS) implementation by ULBs in various cities under the JnNURM central financial assistance offers critical learnings. Soon after the discontinuation of central funding, the ULBs and other agencies tasked with BRTS operations went bankrupt. While many cities, including Delhi, Pune, and Pimpri, have

BRTS, bus-led mass transport has been abandoned in favour of the more-expensive metro rail. Such uncertainty of assured and continuous investments in the projects over the long term is something that metro rail development in India can ill afford. Therefore, it is imperative for national policies to seriously look at the financial health of metro agencies to overcome long-term challenges.

Strategising LVC+: Shenzhen's success with LVC has primarily depended on its unique status as an SEZ with more flexible institutional, policy, and legal frameworks to support TOD. Under the UMTAs' overall supervision, metro agencies could adopt the R+P model after due customisations to adhere to existing regulations to meet the objectives of TOD through multistakeholder partnerships. Designating TOD locations as special zones will help establish a strong link between value capture and value creation, and promote high-density and compact communities in the metro influence zone. Such interventions will help maximise public investments in targeted area improvements and create allied infrastructure. The potential for such customised and location-specific R+P interventions must be explored in cities like Mumbai, where the elevated metro stations on road medians provide ample scope for multi-use development and, importantly, multilevel parking, which no station designs have incorporated. Already, Delhi has reaped rich dividends from leasing out commercial space at its stations. The DMRC's non-farebox revenues—including through advertisement, naming and branding, licencing, and leasing and rental—account for 20 percent of its total revenue. In 2018-19, the DMRC earned INR 31.19 billion (US$416 million) from fares while netting INR 5.64 billion (US$75 million) in non-fare revenue.[123]

The flipside of densification in the Indian context: Revenue raised through densification will expand the financial capacity of the operator through LVC methods and increase farebox collections as a result of increased ridership. However, LVC has been used indiscriminately across cities before the metro rail. Past projects that have aided densification, such as road infrastructure and slum redevelopment, have exploited LVC in some form or other. However, it is important to consider the impact of such use of LVC on the city's well-being. Densification through TOD in Indian cities must be understood differently from its perception in the West, where, but for some global megacities, the population per sq km seldom crosses 5,000-7,000. However, metropolitan densities in India tend to be around 20,000-30,000

persons per sq km. Therefore, though TOD may create more habitable space by providing more vertical floor space per capita, it may lead to undesirable and unsustainable city densities.

Further densification of the dense Indian cities may become counterproductive due to greater congestion, environmental degradation, and increased load on the already overburdened civic infrastructure and services. Additionally, if the TOD fosters exclusion and inequity by catering only to the city's rich (as in Hong Kong), it will further amplify the shortage of affordable housing and encourage more slumisation. Therefore, economic decisions to maximise LVC gains must not compromise the concept of equitable cities and the first Sustainable Development Goal of poverty alleviation, which is a top national priority.

Looking beyond the influence zone: The impact of the metro on Mumbai, Bengaluru, and Delhi has proved that land value appreciation happens beyond the metro's direct influence zone. Several cities have incorporated additional stamp duty on any land and property transactions besides implementing the betterment levy to capture the citywide value appreciation.

The Maharashtra government, for instance, has reintroduced the 1 percent metro cess—waived during the COVID-19 pandemic—in all cities where the metro has been under construction since 2017.[124] In Mumbai, this will mean a total imposition of a 6-percent stamp duty on the entire asset value, while in cities such as Pune and Nagpur, it will grow from 6 percent to 7 percent. The move could be counterproductive. For example, during the two-year waiver, major cities in Maharashtra registered an unprecedented increase in property registrations, yielding the best-ever recovery of INR 5.61 billion (US$75 million) worth of stamp duty in February 2022.[125] Pune registered a 92-percent increase in registration and 59-percent growth in stamp duty collection in 2020 than the previous year. Builders associations have indicated that the reimposition of the metro cess will push residential and commercial property prices up, dampening the market sentiment.

Thus, while enforcing citywide levies to exploit the broader impact of the metro on land value, governments must exercise due caution. Before introducing such sweeping levies, states and cities must first consider the issues of basic amenities, such as water and sanitation, which remain unaddressed in urban India. India will not be able to reap the TOD-LVC dividends unless all the constituents of the TOD ecosystem—the government, financiers, developers and, importantly, the people—derive equitable benefits.

Annexure

Listed below are the stakeholders interviewed as part of the authors' consultations. The views expressed by the interviewees are strictly personal and do no reflect the views of their organisations.

Metro Authorities

R. Ramana, Executive Director, Planning Mumbai Metro Rail Corporation Limited (MMRCL).

Ashwini Bhide, Ex-MD, Mumbai Metro Rail Corporation Limited (MMRCL).

Tomojit Bhattacharya, Public Relations Officer, Delhi Metro Rail Corporation (DMRC).

Anuj Dayal, Executive Director, Delhi Metro Rail Corporation (DMRC).

Manufacturers

Bharat Salhotra, Former MD, Alstom Transport India.

Pritish Chowdhary, Non-Executive Director, Titagarh Wagons India.

Government Representatives

Sharmila Chavaly, Joint Secretary, Finance, Indian Infrastructure Finance Company.Ltd; and Former Member, Railway Board.

Dr Ramanath Jha, Ex Metropolitan Commissioner, Mumbai Metropolitan Region Development Authority.

Indian Railways

Vivek Sahai, Former Chairman, Railway Board.

Shri Prakash, Former Railway Board Member.

Research Organisations

Jaya Dhindaw, Program Director, Urban Development, WRI.

Ravi Gadepalli, Consultant, International Association of Public Transport and World Bank.

Endnotes

1 Ministry of Housing and Urban Affairs, Government of India, *Urban Statistics Handbook*, 2019, https://mohua.gov.in/pdf/5c80e2225a124Handbook%20of%20Urban%20Statistics%202019.pdf

2 Worldometer, *World Population by Country, https://www.worldometers.info/world-population/?&utm_campaign=?#density*

3 Ministry of Road Transport and Highways, Government of India, *Road Transport Yearbook*, 2018, https://morth.nic.in/sites/default/files/RTYB-2017-18-2018-19.pdf

4 Ministry of Housing and Urban Affairs, Government of India, *National Transit Oriented Development (TOD) Policy*, 2017, https://mohua.gov.in/upload/whatsnew/59a4070e85256Transit_Oriented_Developoment_Policy.pdf

5 Ministry of Housing and Urban Affairs, Government of India, *Presentation on Metro Rail Sector*, 2021, https://mohua.gov.in/upload/uploadfiles/files/Metro%20Rail%20_%20MoHUA.pdf

6 "Urban Transport and the Role of Metro Rail," *Trafficinfratech,* April 1, 2013, https://www.trafficinfratech.com/urban-transport-and-the-role-of-metro-rail/

7 "Metro Rail Projects in India – Quick Snapshot", *The Metro Rail Guy,* https://themetrorailguy.com/metro-rail-projects-in-india/

8 Ministry of Housing and Urban Affairs, Government of India, "Standard Specifications of Light Urban Rail System "Metrolite", https://mohua.gov.in/upload/uploadfiles/files/Standards_for_Light_Urban_Rail_Transit_System_(Metro%20Lite)_in_India.pdf

9 "Metro-rail in India high on construction cost,", *ConstructionWorld.in*, April 1, 2019, https://www.constructionworld.in/transport-infrastructure/metro-rail-and-railways-infrastructure/metro-rail-in-india-high-on-construction-cost/20883

10 UITP, *Performance of Indian metro systems: Lessons for upcoming urban rail projects,* 2021, https://cms.uitp.org/wp/wp-content/uploads/2022/01/Knowledge-Brief-November-2021.pdf

11 Ministry of Housing and Urban Affairs, Government of India, *Metro Rail Policy,* 2017, https://www.mohua.gov.in/upload/whatsnew/59a3f7f130eecMetro_Rail_Policy_2017.pdf

12 United Nations Economic and Social Commission for Asia and the Pacific, "A Primer to Public-Private Partnerships in Infrastructure Development," UNESCAP, https://www.unescap.org/ttdw/ppp/ppp_primer/211_special_purpose_vehicle_spv.html

13 Ministry of Housing and Urban Affairs, *Metro Rail Policy*

14 Ministry of Housing and Urban Affairs, Government of India, *Appraisal Guidelines for Metro Rail Project Proposals,* 2017, https://mohua.gov.in/upload/uploadfiles/files/Appraisal%20Guidelines%20for%20Metro%20Rail.pdf

15 Ministry of Urban Development, Government of India, *Value Capture Finance Policy Framework,* 2017*, https://mohua.gov.in/upload/whatsnew/59c0bb2d8f11bVCF_Policy_Book_FINAL.pdf*

16 UITP, *World Metro Figures, 2018*, https://cms.uitp.org/wp/wp-content/uploads/2020/06/Statistics-Brief-World-metro-figures-2018V3_WEB.pdf

[17] Ministry of Commerce and Industry, *Public Procurement (Preference to Make in India), Order 2017- Revision,* 2020, https://www.meity.gov.in/writereaddata/files/PPP_MII_Order_dated_16_09_2020.pdf

[18] Ministry of Housing and Urban Affairs, Government of India, *Revision of Minimum Local Content of various metro rail components under MI-PPP order, 2017 of DPIIT*, October 14, 2020, https://mohua.gov.in/upload/uploadfiles/files/Revision%20of%20Minimum%20Local%20Content%20of%20various%20Metro%20Rail%20Components%20under%20PPP-MII%20Order%202017%20of%20DPIIT.pdf

[19] Ministry of Housing and Urban Affairs, Government of India, *Report of the Committee on Standardization and Indigenisation of Metro Railways, Systems and Sub-Systems*, 2013, https://mohua.gov.in/upload/uploadfiles/files/Report%201Base%20Paper%20on%20STANDARDIZATION%20AND%20INDIGENISATION%20Copy.pdf

[20] Naveen Menezes, "Metro to dig deep with German, Chinese boring machines," *BangaloreMirror*, July 11, 2020, https://bangaloremirror.indiatimes.com/bangalore/others/metro-to-dig-deep-with-german-chinese-boring-machines/articleshow/76901452.cms

[21] Ministry of Housing and Urban Affairs, Government of India, *Report of the Sub-Committee on Traction Systems, General Power Supply Arrangements and Energy Efficient Systems for Metro Railways*, 2013, https://mohua.gov.in/upload/uploadfiles/files/Report%204%20Traction%20System.pdf

[22] Ministry of Housing and Urban Affairs, Government of India, *Standardization/Indigenization of Electrical & Electromechanical Metro Rail Components*, 2018, https://mohua.gov.in/upload/uploadfiles/files/STANDARDIZATION-INDIGENIZATION%20OF%20ELECTRICAL%20AND%20ELECTROMECHANICAL.pdf

[23] Ministry of Housing and Urban Affairs, Government of India, Metro Neo System (Presentation), 2021, https://mohua.gov.in/upload/uploadfiles/files/Metro%20Neo%20System.pdf

[24] Statista, *Leading manufacturers of metro rolling stock worldwide*, 2019, https://www.statista.com/statistics/1148125/leading-metro-rolling-stock-manufacturers-in-the-world/

[25] Viviana Zhu, "Europe-China rail competition – Bigger is better?," *Institut Montaigne*, 2019, https://www.institutmontaigne.org/en/analysis/europe-china-rail-competition-bigger-better

[26] "90 per cent of Delhi Metro coaches are manufactured in India," *The Economic Times,* March 27, 2015, https://economictimes.indiatimes.com/industry/transportation/railways/90-per-cent-of-delhi-metro-coaches-are-manufactured-in-india/articleshow/46719323.cms?from=mdr

[27] "Metro companies will have to buy 75% coaches, 25% equipment made in India," *The Business Standard,* April 23, 2017, https://www.business-standard.com/article/companies/metro-companies-will-have-to-buy-75-coaches-25-equipment-made-in-india-117042300388_1.html

[28] "Mumbai metro corridor: BEML bags Rs 3,015-crore contract," *Financial Express*, November 23, 2018, https://www.financialexpress.com/industry/mumbai-metro-corridor-beml-bags-rs-3015-crore-contract/1390917/

[29] "BEML, RITES ink pact, to jointly bid for Metro systems, export of rolling stock," *The Financial Express*, December 16, 2021, https://www.financialexpress.com/industry/beml-rites-ink-pact-to-jointly-bid-for-metro-systems-export-of-rolling-stock/2381563/

[30] "Alstom completes Bombardier Transportation takeover," *International Railway Journal,* January 29, 2021, https://www.railjournal.com/financial/alstom-completes-bombardier-transportation-takeover/

[31] "Alstom inaugurates Asia's largest components manufacturing facility in Coimbatore; details," *The Financial Express*, November 17, 2021, https://www.financialexpress.com/infrastructure/alstom-inaugurates-asias-largest-components-manufacturing-facility-in-coimbatore-details/2370931/

[32] "Siemens supplies propulsion system to Indian Railways," *The Economic Times,* June 12,2019, https://economictimes.indiatimes.com/industry/indl-goods/svs/engineering/siemens-supplies-propulsion-system-to-indian-railways/articleshow/69759279.cms?from=mdr

[33] Ministry of Housing and Urban Affairs, Government of India, *Report of the Sub-Committee on Standardization of Signalling and Train Control Systems for Metro Railways*, 2013, https://mohua.gov.in/upload/uploadfiles/files/Report%205%20Signalling%20and%20Train%20Control%20Systems.pdf

[34] Ministry of Railways, Government of India, *An Introductory Handbook on Communications Based Train Control (CBTC)*, 2021, https://pdf4pro.com/view/an-introductory-handbook-on-communications-based-train-73ceb8.html

[35] Tedd L. Snyder, "Communications-Based Train Control Interoperability Developments at New York City Transit." *14th International Conference on Automated People Movers and Automated Transit Systems*, 2013, https://ascelibrary.org/doi/abs/10.1061/9780784412862.040

[36] Department for Promotion of Industry and Internal Trade, Ministry of Commerce and Industry, Government of India, *Foreign Direct Investment Newsletters (erstwhile SIA Newsletter)*, October 2021 and October 2011, https://dpiit.gov.in/publications/si-news-letters

[37] Sanjaya Lall, and Morris Teuba, ""Market-stimulating" technology policies in developing countries: A framework with examples from East Asia," World Development 26, no. 8 (1998): 1369-1385, https://www.sciencedirect.com/science/article/abs/pii/S0305750X98000710

[38] Yatang Lin, Yu Qin, and Zhuan Xie. "International technology transfer and domestic innovation: evidence from the high-speed rail sector in China," *London School of Economics and Political Science, CEP, London, UK.* 2015, http://cesi.econ.cuhk.edu.hk/wp-content/uploads/Lin_Yatang_International-Technology-Transfer-and-Domestic-Innovation_Evidence-from-the-High-Speed-railway-Sector-in-China.pdf

[39] Knut Blind, The Impact of Standardization and Standards on Innovation, *Nesta Working Paper 13/15,* 2013, https://media.nesta.org.uk/documents/the_impact_of_standardization_and_standards_on_innovation.pdf

[40] Municipal Corporation of Greater Mumbai, *Comprehensive Mobility Plan (CMP) for Greater Mumbai*, April 2016, https://portal.mcgm.gov.in/irj/go/km/docs/documents/MCGM%20Department%20List/Roads%20and%20Traffic/Docs/CMP%20for%20Greater%20Mumbai/Executive%20Summary/Executive%20Summary.pdf

[41] Dhindaw J., Kumaraswamy S. K., Prakash V. S., Chanchani R., and Deb A, "*Synergizing Land Value Capture and Transit-Oriented Development: A Study of Bengaluru Metro*", World Resources Institute India, 2021, https://www.wri.org/research/synergizing-land-valuecapture-tod

[42] Ministry of Housing and Uban Development, *Value Capture Finance Policy Framework*

[43] Abdul Abaid, Kathleen Farrin and Chris Hale, *Sustaining Transit Investments in Asian Cities: A Beneficiary-funding and Land Value Capture Perspective*, Asian Development Bank, April 2019, https://www.adb.org/sites/default/files/publication/496991/sustaining-transit-investment-asia-cities.pdf

[44] "Synergizing Land Value Capture and Transit-Oriented Development: A Study of Bengaluru Metro"

[45] Oregon Metro, *2020 Annual Report: Transit Oriented Development Program*, 2020, https://www.oregonmetro.gov/sites/default/files/2021/07/29/TOD_Annual_report%20_2020_7_9_21.pdf

[46] Abdul Abaid, Kathleen Farrin and Chris Hale, *Sustaining Transit Investments in Asian Cities: A Beneficiary-funding and Land Value Capture Perspective*, Asian Development Bank, April 2019, https://www.adb.org/sites/default/files/publication/496991/sustaining-transit-investment-asia-cities.pdf

[47] Mathieu Verougstraete and Han Zeng, "Land Value Capture Mechanism: The Case of the Hong Kong MTR", *Public-Private Partnerships Case Study $4,* UNESCAP, July 2014

[48] "Innovative Infrastructure Financing through Value Capture in Indonesia", ADB, May 2021, https://www.adb.org/sites/default/files/publication/702071/innovative-infrastructure-financing-indonesia.pdf

[49] Haraya Buensuceso and Cesar Purisima, "Funding Transport Infrastructure Development in the Philippines: A Roadmap Toward Land Value Capture", Milken Institute, July 2018, https://milkeninstitute.org/sites/default/files/reports-pdf/LVC-Whitepaper_2.pdf

[50] Sutee Anantsuksomsri and Nij Tontisirin, "The Impacts of Mass Transit Improvements on Residential Land Development Values: Evidence from the Bangkok Metropolitan Region", *Urban Policy and Research* (Routledge), Vol. 33, No. 2, 195–216, http://dx.doi.org/10.1080/08111146.2014.982791, 2015

[51] Sharad Saxena, "Transforming Cities with Land Value Capture", *Asian Development Blog,* ADB, August 2017, https://blogs.adb.org/blog/transforming-cities-land-value-capture

[52] Edwin Loo, "Lessons from Singapore about Land Value Capture", RTPI, 2017, https://www.rtpi.org.uk/blog/2017/april/lessons-from-singapore-about-land-value-capture/

[53] Swamy, Shivanand, "Urban Transport Developments in India under NUTP and JnNURM", John Diandas Memorial Lectures, Sri Lanka, 2014, https://www.researchgate.net/publication/287959369_Urban_Transport_Developments_in_India_under_NUTP_and_JnNURM

[54] Ministry of Housing and Urban Development, Government of India, *National Urban Transport Policy*, 2017, https://smartnet.niua.org/sites/default/files/resources/National%20Urban%20Transport%20Policy.pdf

[55] Ministry of Housing and Urban Development, Government of India, *National Transit Oriented Development (TOD) Policy*, 2017, https://mohua.gov.in/upload/whatsnew/59a4070e85256Transit_Oriented_Developoment_Policy.pdf

[56] Ministry of Housing and Urban Affairs, *Metro Rail Policy 2017*

[57] Government of India, *The Constitution (74th Amendment Act)*, 1992, https://mohua.gov.in/upload/uploadfiles/files/74th_CAA13.pdf

[58] Ramanath Jha, "*The unfinished business of decentralised urban governance in India*", Observer Research Foundation, 2020, https://www.orfonline.org/wp-content/uploads/2020/02/ORF_Issue_Brief_340_Decentralised_Governance.pdf

[59] Himanshu Arora, "Impact of Metro Railway on Plots in Cities with Upcoming Metro Service", *Magicbricks*, October 27, 2021, https://www.magicbricks.com/blog/impact-of-metro-railway-on-plots-in-cities-with-upcoming-metro-service/124988.html

[60] Arora, "Impact of Metro Railway on Plots in Cities with Upcoming Metro Service"

[61] "Bangalore Namma Metro: A New Awakening", *CommonFloor*, December 9, 2013, https://www.commonfloor.com/guide/bangalore-namma-metro-a-new-awakening-34901

[62] Nagpur Metro Rail Project, Project Profile, https://www.metrorailnagpur.com/project-profile

[63] "Hyderabad Metro Phase 1 – Information, Route Maps, Tenders and Updates", *The Metro Rail Guy*, https://themetrorailguy.com/hyderabad-metro-phase-1-information-map/#:~:text=Larsen%20and%20Toubro%20Metro%20Rail,opened%20on%20February%207%202020

[64] "Ahmedabad Metro to be inaugurated today; all you need to know about the new train network", *Business Today*, March 4, 2019, https://www.businesstoday.in/latest/economy-politics/story/ahmedabad-metro-to-be-inaugurated-today-all-you-need-to-know-about-the-new-train-network-175519-2019-03-04

[65] Renu Yadav, "Metro corridors led to 15-20 % rise in land prices in cities: JLL Report", *LiveMiint*, April 14, 2021, https://www.livemint.com/news/india/metro-corridors-led-to-15-20-rise-in-land-prices-in-cities-jll-report-11618403248904.html

[66] Aishwarya Iyer, "Shaped by the Metro: How connectivity boosts real estate", *Hindustan Times*, October 5, 2019, https://www.hindustantimes.com/real-estate/shaped-by-the-metro-how-connectivity-boots-real-estate/story-u7NAlHRRqmRh9r15HzibOO.html

[67] Vinod Shah, "Exclusive Interview: In conversation with SVR Srinivas, Metropolitan Commissioner, MMRDA, 6 April 2022, https://urbantransportnews.com/news/exclusive-interview-in-conversation-with-svr-srinivas-metropolitan-commissioner-mmrda

[68] Bangalore Metro Rail Corporation Ltd., "*15th Annual Report 2020-21*", https://english.bmrc.co.in/FileUploads/54c52e_BondFiles.pdf

[69] BMRCL, "*15th Annual Report 2020-21*"

[70] Christin Mathew Philip, "Bengaluru: Namma Metro's cash loss increased by Rs 26 crore", *The Times of India*, August 28, 2020, https://timesofindia.indiatimes.com/city/bengaluru/bengaluru-namma-metros-cash-loss-up-by-rs-26-crore/articleshow/77787670.cms

[71] S. Lalitha, "Metro makes big bucks, but huge loans weigh it down", *The New Indian Express*, April 8, 2018, https://www.newindianexpress.com/states/karnataka/2018/apr/08/metro-makes-big-bucks-but-huge-loans-weigh-it-down-1798578.html

[72] BMRCL, "*15th Annual Report 2020-21*"

[73] "Bengaluru: Namma Metro needs 12 lakh daily ridership to break even", *The Times of India*, December 5, 2021, https://timesofindia.indiatimes.com/city/bengaluru/metro-needs-12-lakh-daily-ridership-to-break-even/articleshow/88098517.cms

[74] "Synergizing Land Value Capture and Transit-Oriented Development: A Study of Bengaluru Metro"

[75] Pradeep Singh Kharola, "Innovative Financing Techniques", (presentation to Ministry of Housing and Urban Development), Government of India, June 11, 2016

[76] Kharola, "Innovative Financing Techniques"

[77] Kharola, "Innovative Financing Techniques"

[78] KV Aditya Bharadwaj, "Industry, citizen groups oppose proposal to reduce permissible FAR", *The Hindu*, July 15, 2017, https://www.thehindu.com/news/cities/bangalore/industry-citizen-groups-oppose-proposal-to-reduce-permissible-far/article19281541.ece?homepage=true

[79] "Bengaluru Transport Oriented Development Policy, 2019"

[80] Manu Aiyappa, "Karnataka government sets ground for revised transit-oriented policy in Bengaluru", *The Times of India,* November 21, 2021, https://timesofindia.indiatimes.com/city/bengaluru/karnataka-government-sets-ground-for-revised-transit-oriented-policy-in-bengaluru/articleshow/87640678.cms

[81] Christin Mathew Philip, "Bengaluru: Hit by curbs, BMRCL mulls commercial growth at stations", *The Times of India*, June 12, 2021, https://timesofindia.indiatimes.com/city/bengaluru/bengaluru-hit-by-curbs-bmrcl-mulls-commercial-growth-at-stations/articleshow/83453971.cms

[82] Makarand Gadgil, "Mumbai Metro Services to start on Sunday amid tariff dispute," *Mint*, June 8, 2014, https://www.livemint.com/Politics/jgQox7qqUnR5siYQngF1tM/Mumbai-to-get-modern-metro-rail-from-Sunday.html

[83] Reliance Mumbai Metro One, FAQs, https://www.reliancemumbaimetro.com/metro-faq#Project

[84] "Mumbai Metro Rolls Out: 11 interesting facts", *The Economic Times*, June 9, 2014, https://economictimes.indiatimes.com/infrastructure/mumbai-metro-rolls-out-11-interesting-facts/11-4-km-versova-andheri-ghatkopar-stretch/slideshow/36287345.cms

[85] "Metro railway to impact Mumbai realty, says Jones Land LaSalle", *The Economic Times*, June 6, 2015, https://economictimes.indiatimes.com/wealth/personal-finance-news/metro-railway-to-impact-mumbai-realty-says-jones-lang-lasalle/articleshow/36156611.cms

[86] Mumbai Metropolitan Region Development Authority, Mumbai Metro Line 1, Project Features, https://mmrda.maharashtra.gov.in/metro-line-1#

[87] Manthan K. Mehta, "Metro ridership touches 2 lakh but still 50 per cent less than pre-Covid times", *The Times of India*, December 13, 2021, https://timesofindia.indiatimes.com/city/mumbai/metro-ridership-touches-2-lakh-but-still-50-per-cent-less-than-pre-covid-times/articleshow/88263913.cms

[88] "Bombay High Court rejects proposal to hike Mumbai Metro fares", *The Economic Times*, December 5, 2017, https://economictimes.indiatimes.com/industry/transportation/railways/bombay-high-court-rejects-proposal-to-hike-mumbai-metro-fares/articleshow/61927071.cms

[89] "Mumbai metro fares hiked by Rs 5, effective from Dec 1", *India Today*, November 27, 2015, https://www.indiatoday.in/india/story/mumbai-metro-fares-hiked-by-rs-5-effective-from-dec-1-274710-2015-11-27

[90] "High Court Restraints Mumbai Metro from Raising Fares", *Press Trust of India,* December 4, 2017, https://www.ndtv.com/mumbai-news/high-court-restrains-mumbai-metro-from-hiking-fares-1783382

[91] Manthan K. Mehra and Bhavika Jain, "MMRDA may take over operations of 'bleeding' Metro One", *The Times of India*, August 21, 2020, https://timesofindia.indiatimes.com/city/mumbai/mmrda-may-take-over-ops-of-bleeding-metro-one/articleshow/77664321.cms

[92] Rohit Sharma, Peter Newman, "Can Land Value Capture make PPPs competitive in fares? A Mumbai Case Study", *Transport Policy* 64 (2018), 123-131, https://espace.curtin.edu.au/handle/20.500.11937/67809

[93] Rohit Sharma, Peter Newman, "Can Land Value Capture make PPPs competitive in fares? A Mumbai Case Study"

[94] "Urban Transport: Unlocking the realty potential", Knight Frank, 2016, https://content.knightfrank.com/research/1043/documents/en/mumbai-infrastructure-development-analysis-3771.pdf

[95] "Urban Transport: Unlocking the realty potential"

[96] Adusumilli Uma, "Value Capture Financing: Experience of MMRDA and CIDCO", Workshop on TOD and VCF, NRCTC and NIUA, June 15, 2019, https://ncrtc.in/wp-content/uploads/2019/06/04_-UMA-A._-MMRDA-and-CIDCO.pdf

[97] Meenakshi Sinha, "Harnessing land value capture: Perspectives from India's urban rail corridors, *Land Use Policy*", Volume 108, (2021), https://www.sciencedirect.com/science/article/abs/pii/S0264837721002490?via%3Dihub

[98] "R+P Model for Sustainable Urban Development", Hong Kong Trade Development Council, March 27, 2015, https://portal.hktdc.com/ires/en/s/RPModel

[99] "Brouhaha over Mantri TDR in BBMP Council", *The New Indian Express*, June 29, 2011, https://www.newindianexpress.com/cities/bengaluru/2011/jun/29/brouhaha-over-mantri-tdr-in-bbmp-council-267572.html

[100] Meenakshi Sinha, "Harnessing land value capture: Perspectives from India's urban rail corridors, *Land Use Policy*"

[101] Rohit Sharma, Peter Newman, "Does Urban Rail Increase Land Value in Emerging Cities? Value Uplift from Bangalore Metro", *Transportation Research Part A: Policy and Practice*, Volume 17, (2018), https://www.sciencedirect.com/science/article/pii/S0965856417303178

[102] "Does Urban Rail Increase Land Value in Emerging Cities? Value Uplift from Bangalore Metro"

[103] "Value Capture Finance in Transit Oriented Development", NIUA, 2020, https://niua.org/intranet/sites/default/files/623.pdf

[104] Navin Singh, "The case for land value tax", *The Hindu*, May 13, 2016, https://www.thehindu.com/opinion/open-page/the-case-for-a-land-value-tax/article5618157.ece

[105] Sunita Mishra, "What is land conversion and how is it done?", *Housing.com*, March 17, 2020, https://housing.com/news/what-is-land-conversion-and-how-is-it-done/#:~:text=Charges%20for%20land%20use%20change,Rs%2024%2C777%20per%20square%20metre.

[106] Sunita Mishra, "Do you have pay tax on vacant land in India?", *Housing.com*, March 17, 2021, https://housing.com/news/vacant-land-tax/

[107] BV Mahalaxmi, "Hyderabad Metro: With Phase 1 complete, the city now boasts India's second-biggest Metro network", *The Financial Express*, February 24, 2020

[108] Kinght Frank, "Value Capture Financing vis-à-vis Transit Oriented Development: Case of Nagpur and Hyderabad Metro", presentation made to National Capital Region Transport Corporation, https://ncrtc.in/wp-content/uploads/2019/06/07_-AJAY-A._-NAGPUR-VCF.pdf

[109] Sandeep Kumar, "L&T Metro at Hyderabad: Winning with Transit Oriented Development and Retail", *Indiaretailing.com*, https://www.indiaretailing.com/2022/04/01/shopping-centre/lt-metro-rail-hyderabad-winning-with-transit-oriented-development-and-retail/

[110] BV Mahalaxmi, ""Hyderabad Metro: With Phase 1 complete, the city now boasts India's second-biggest Metro network"

[111] Siddhant Kalra, "Did Namma Metro reverse engineer CMP for Cenre's funding?", *Citizen Matters*, January 29, 2020, https://bengaluru.citizenmatters.in/bengaluru-metro-bmrcl-comprehensive-mobility-plan-validity-umta-central-funding-42341

[112] Naveen Menezes, "Cost and time overrun marks Bengaluru Metro phase 1", *The Economic Times*, March 9, 2017, https://economictimes.indiatimes.com/industry/transportation/railways/cost-and-time-overrun-marks-bengaluru-metro-phase-i/articleshow/57550535.cms?from=mdr

[113] Nauzer Bharucha, "Cost of Mumbai Metro 3 soars by Rs 10,000 crore in 5 years, *The Times of India*, June 6, 2021, https://timesofindia.indiatimes.com/city/mumbai/cost-of-mumbai-metro-3-soars-by-rs-10000cr-in-5-yrs/articleshow/83269265.cms

[114] "Bandra Worli Sealink: Hi-tech incompetence?", *The Economic Times*, July 1, 2009, https://web.archive.org/web/20101012032923/http://economictimes.indiatimes.com/features/Bandra-Worli-Sea-Link-Hi-tech-incompetence/articleshow/4723969.cms

[115] Matthew Keegan, "How public transport actually turns a profit in Kong Kong", *The Guardian*, March 19, 2019, https://www.theguardian.com/cities/2019/mar/19/how-public-transport-actually-turns-a-profit-in-hong-kong

[116] World Bank and Imperial College London Railway and Transport Strategy Centre, *The Operator's Story*, February 2017, https://www.imperial.ac.uk/media/imperial-college/research-centres-and-groups/centre-for-transport-studies/rtsc/world-bank/OperatorsStory_Hong-Kong-MTR_Final-060717.pdf

[117] Hana Davis, "Explainer | Hong Kong's MTR train system explained: profits, property and punctuality spelt success before the scandals", South China Morning Post, March 20, 2019, https://www.scmp.com/news/hong-kong/transport/article/3003698/hong-kongs-mtr-train-system-explained-profits-property-and

[118] Hana Davis, "Explainer | Hong Kong's MTR train system explained: profits, property and punctuality spelt success before the scandals"

[119] Lulu Xue and Wangli Fang, "*Rail plus property development in China: The pilot case of Shenzhen*", World Resources Institute, Working Paper, March 2017, https://files.wri.org/d8/s3fs-public/Rail_Plus_Property_Development_In_China_The_Pilot_Case_Of_Shenzhen.pdf

[120] "Rail plus property development in China: The pilot case of Shenzhen"

[121] "Rail plus property development in China: The pilot case of Shenzhen"

[122] Tanushree Venkatraman, "Metros across India run into losses: Study", *Hindustan Times*, January 15, 2020, https://www.hindustantimes.com/mumbai-news/metros-across-indiarun-into-losses-study/story-EB0TiJ15Wjh8ES5ffJ3OXP.html

[123] "Metro cess on property registrations in Mumbai, 3 Maharashtra cities back after COVID-19 break", *Press Trust of India,* April 1, 2022, https://economictimes.indiatimes.com/industry/services/property-/-cstruction/metro-cess-on-property-registrations-in-mumbai-3-maharashtra-cities-back-after-covid-19-break/articleshow/90592634.cms

[124] Kailash Babar, "Builders urge Maharashtra to defer metro cess levy by two years", *The Economic Times*, March 4, 2022, https://economictimes.indiatimes.com/industry/services/property-/-cstruction/builders-urge-maharashtra-to-defer-metro-cess-levy-by-two-years/articleshow/90189594.cms?_oref=cook&from=mdr

[125] "CREDAI – Pune metro opposes government's proposal to levy 1% metro cess", *Punekar News*, March 8, 2022, https://punekarnews.in/credai-pune-metro-opposes-governments-proposal-to-levy-1-metro-cess/#:~:text=This%20cess%20will%20be%20for,is%20under%20construction%20since%202017.

About the Authors

Promit Mookherjee is an Associate Fellow at ORF's Centre for Economy and Growth.

Dhaval Desai is Senior Fellow and Vice President at ORF Mumbai.

OBSERVER RESEARCH FOUNDATION
Ideas • Forums • Leadership • Impact

20, Rouse Avenue Institutional Area
New Delhi - 110 002, INDIA
+91-11-35332000 Fax: +91-11-35332005
contactus@orfonline.org
www.orfonline.org

d·i·e
Deutsches Institut für Entwicklungspolitik
German Development Institute

German Development Institute / Deutsches Institut für Entwicklungspolitik (DIE)
Tulpenfeld 6, D-53113 Bonn, Germany
E-mail: DIE@die-gdi.de
Phone: +49 (0)228 94927-0
Website: www.die-gdi.de/en/