

Metro Rail Infrastructure Projects in India: Challenges and Way Forward

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Abstract: This paper focuses on the significance of public transport infrastructure facilities in the context of increasing urbanization. Case examples of metro rail projects are studied to find the common issues and risks during the planning and execution stages. The study of projects resulted in the identification of significant challenges in the metro rail infrastructure projects. Evidence from the literature review of studies conducted in similar areas is presented and research gap is identified. The risks related to delay and demand are found common in the case examples of commissioned metro rail projects in India. The paper proposes identification and investigation of the inter-relationship between the factors contributing to delay and demand shortfall in urban rail-based infrastructure projects.

Index Terms—Infrastructure Projects, Metro Rail, Risks, Delays, Demand.

I. INTRODUCTION

Developing countries are experiencing in-migration and population growth leading to rapid urbanization. The growth of urban population in developing countries for the next four decades is estimated at an increase of five million per month (UN-Habitat, 2008). India is no exception to this rising trend of urbanization. India observed growth in urban population from 27.81 percent to 31.16 percent between 2001 and 2011 (*Census of India*, 2011). India is expected to witness the highest level of urbanization in the next four decades (Heilig, 2012). In an estimation, the urban population of India is projected to touch 600 million by 2031 (Ahluwalia et al., 2014). The number of million-plus agglomerations in India has increased to more than 50 (*Census of India*, 2011). There exists inadequacy in planning and development provisions to facilitate the growing urban centers. The rise in urban population and the growth of urban centres is leading to problems of the housing shortage, sanitation, slums, environmental degradation, solid waste management, and transportation. The widening gap between demand and supply of urban infrastructure provisions is a challenge for the local bodies and policy makers.

The shift of Indian demography from rural areas to urban locations and concentration of population in a limited number of cities has raised many issues related to town planning and infrastructure development in general and transportation in particular. Modern cities have grown in a haphazard and unplanned manner leading to congestion on roads and other traffic-related problems. It results in fuel wastage, enhanced carbon dioxide emissions and increased travel time for commuter affecting the quality of life. In this situation, developmental planning requires more emphasis on augmentation of the public transport system. The provision of efficient public transportation infrastructure is suggested to improve traffic congestion problems and reduce emissions (Fouracre, Drunkerley and Gardner, 2003).

Urban rail, in the category of the mass rapid transit system, decreases the ownership of private vehicles and improve the economics of large cities (Newman and Kenworthy 2015). These projects are complex and characterized by large capital investments, long stipulated time of completion, multiple stakeholders and broad set of beneficiaries. The focus of the Metro Rail projects is to ensure the most efficient urban rail system in terms of revenue while maintaining a high ridership level. The paper focuses on the status of metro rail projects in India and presents case studies of selected projects. It also highlights the challenges in metro rail projects executed in India and key risks concerning the project feasibility.

II. METRO RAILS PROJECTS IN INDIA

The Indian government is aiding projects of metro rails since 2011 in the cities with two million population (Ministry of Urban Development, 2017). The threshold of this population limit was later reduced to one million for allowing medium-size cities to benefit from these projects (Press Information Bureau, 2014). Currently, more than ten Indian cities have commissioned metro rail projects and over 50 Indian cities are expected to be facilitated by metro rails. The first metro rail project in India was the Kolkata Rail Project, which was implemented in 1984 (Metro Railway Kolkata, 2015). Concerning the length of network and ridership, Delhi Metro has the biggest metro rail network in India. Delhi metro has the busiest metro rail network and is the second oldest commissioned project after Kolkata metro. The other cities in India with commissioned projects include Mumbai, Bangalore, Gurgaon, Chennai, Hyderabad,

Kolkata, Kochi, Jaipur and Lucknow. Metro rail projects require large capital costs and are characterized under three heads based on the source of investment: public funded, private funded, and public-private partnership (PPP). Apart from Delhi Airport metro, Mumbai Metro, Rapid Metro -Gurgaon and Hyderabad Metro, the other operational Indian metro rails are completely financed by public money.

2.1 Delhi Metro

Delhi Metro consists of more than 213 Km corridor and daily ridership exceeds 2.6 million (DMRC, 2016). Delhi Metro Rail has been constructed by Delhi Metro Rail Corporation (DMRC) in two phases initially. The remarkable feature of the first two phases is the accomplishment of the project without delay and cost overrun (World Bank, 2012; DMRC, 2017). The success of the Delhi Metro as a transit system lies in providing economic and environmental benefits to the city. Delhi metro is estimated to save an annual emission of 16 million tonnes due to the modal shift of personal vehicle commuters (RITES Ltd., 2011). The cumulative emission reduction was projected as 4.808 million tonnes in the project lifetime of 70 years. However, the later phases of the project featured with the delay have incurred a loss of revenue. The main reason for delay included delay in site handover to the contractor leading to litigation and disputes.

2.2 Gurgaon Metro

In contrast to Delhi Metro Rail, which is government funded, Rapid Metro Gurgaon is a privately financed system on a Build Operate Transfer -BOT basis, with a 99-year concession period. The project spans 6 km and is integrated with the Delhi Metro line by pedestrian connectivity (IL&FS, 2012). The project experienced substantial delays in completion due to non-receipt of statutory approvals in time from different authorities. As an outcome of delay, the project compromised on cost compliance (RMRGL, 2014). The initial cost of the project was estimated at INR 10880 million, whereas the actual cost came out to be INR 12390 million. In this case, cost overrun of INR 1510 million is attributable to delay in project approval and execution. Another issue with the Gurgaon Rapid Metro was delay in projected commercial development projects along and around the corridor, which affected the ridership of the project. The availability of other informal and cheaper modes of transport also resulted in demand shortfall for the project. The project experienced demand shortfall since the commissioning year. However, there was a noticeable rise in the demand as ridership increased from 18,614 (2014) to 42,000 (2015). During the period 2014-2016, the fare-box revenue contributed only 39 percent to the total earnings of the project (Deloitte Haskins and Sells, 2015; Kumar, 2014). Even though the ridership has increased substantially over the last few years, still the gap between the estimated and actual ridership is huge and the project can attract only 40 percent of the projected ridership.

2.3 Mumbai Metro

The third case study of Mumbai metro project phase-I, commissioned in 2014, is an example of public-private partnership. The project is executed on Build-Operate-Own-Transfer-BOOT model with a concession period of 35 years. The equity share of the concessionaire and local government is 74% and 26% respectively (Reliance Mumbai Metro, 2013). The project suffered extensive delays and cost overruns during various stages of execution. The impact of delay on the total project cost overruns was reported and it was found that 83% of the project cost overruns are attributable to delay (Kulkarni and Shaikh, 2014). The complicated and time taking procedure of getting statutory approvals from multiple agencies is a hindrance for infrastructure projects. The progress of the Mumbai metro was significantly affected by the challenge of getting in-time approvals.

2.4 Bangalore Metro

Similar instances are observed in other public-financed projects also. The cost of the Bangalore metro project has escalated by 19.3 % and a total cost overrun of 60% is estimated with the existing state of delay in the project (Ray, 2015). Delay in land acquisition has a major contribution in delay of phase -I of Bangalore metro rail project. The extent and frequency of delay in metro projects discourage the involvement of private financiers in such projects.

III. CHALLENGES IN METRO RAIL PROJECTS IN INDIA

It is evident from the discussed metro rail case examples and trends in project structuring that government is exploring different project delivery models for upcoming urban rail projects. The limited finance available with the government necessitates finding new sources of investment. It has resulted in the involvement of private partners in project financing and implementation at various levels. The issues about site handover, getting approvals from the authorities and land acquisition, as discussed in the case studies, led to extensive delays in Delhi, Gurgaon, Mumbai and Bangalore metro rail projects. The reasons for delay in Indian metro rail projects were identified as- shifting of utilities, poor record of utilities, scope change, shortage of construction materials, shortage of labour and lack of data collection are the other factors contributing delay in the commissioning of Indian rail projects (Mittal and Paul, 2018). Delay adversely affects the performance of projects and is responsible for cost overruns (Kulkarni and Shaikh, 2014; RMRGL, 2014; Ray 2015). Cost overruns and uncertainty in financial outcomes leading to deviation from the project's estimated deliverables creates disinterest in the private investors towards the project.

Challenges in rail projects in the transport infrastructure sector are not limited to delay in projects. Uncertainty in demand and over-estimation of ridership also poses hurdles in the feasibility of rail-based projects. A shortfall in demand and over-estimation of ridership question the viability of these projects. Out of these two factors related to the utilization of the facility, over-estimation and under-estimation of ridership has been well recognised and discussed by various researchers (Skamris and Flyvbjerg, 1997; Flyvbjerg et al., 2005; Flyvbjerg, 2007; Flyvbjerg, 2008; Salling and Leleur, 2015; Beria et al., 2018), whereas limited literature is available in support of demand risks investigation. Evidence from metro rail projects in India reflects cases of demand shortfall and possible factors affecting the demand. Incomplete projects, availability of alternate and cheaper modes of transport and last mile connectivity are some of the major reasons for the shortfall in demand (RMRGL, 2014).

On the other hand, the formulation of these projects is guided by socio-economic appraisal, environmental appraisal and cost-benefit analysis. Projected demand for the infrastructure plays a decisive factor in the justification of project. In a study, prioritization of the demand risk factors in case of PPP projects was attempted (Alasad et al., 2014). In this survey-based study, core factors influencing the demand were categorized in different groups. The relative importance of factors was calculated and Analytic Network Process was used to prioritize the influencing factor. In another study, demand risk assessment of toll road projects was done (Alasad, Motawa and Ogunlana, 2013). The study used system dynamics model for demand forecasting in toll road projects. Cost of travel (Pauly et al., 2006), the income of the passenger (Schafer and Victor, 2000; Medlock and Soligo, 2002), and distribution of transportation network (Davidson et al., 1997) were identified as factors affecting the demand of an upcoming transit facility in similar investigations. Given the frequent occurrence of demand shortfall in metro rail projects, there is a need to explore the significant reasons affecting the demand and utilization.

IV. CONCLUSION

Optimum utilization and timely completion ascertain the financial and economic sustainability of metro rail projects. Delays and shortfall of demand cause a threat to the viability of these projects. Metro rail projects in India are commonly characterized by delay in completion and shortfall in demand. Various studies refer to risk assessment and suggest risk mitigation strategies in different sectors of infrastructure construction projects. Even though there is a common occurrence of delay and demand shortfall in metro rail projects, still, evidence in the form of established literature addressing the issues in urban rail sector are very limited. This paper establishes the need to study the causes of delay and demand shortfall in metro rail projects. It also proposes to investigate the inter-relationship between the factors contributing to delay and demand shortfall in similar infrastructure projects.

REFERENCES

- [1] Ahluwalia, I.J., Kanbur, R. and Mohanty, P.K. eds., 2014. *Urbanisation in India: Challenges, opportunities and the way forward*. SAGE Publications India.
- [2] Alasad, R., Motawa, I. and Ogunlana, S., 2013. A System Dynamics-Based Model For Demand Forecasting In PPP Infrastructure Projects—A Case Of Toll Roads. *Organization, technology & management in construction: an international journal*, 5(Special), pp.0-0.
- [3] Alasad, R., Motawa, I., Ogunlana, S. and Boateng, P., 2014. Prioritization of Demand Risk Factors in PPP infrastructure projects. In *Construction Research Congress 2014: Construction in a Global Network* (pp. 1359-1368).
- [4] Beria, P., Grimaldi, R., Albalade, D. and Bel, G., 2018. Delusions of success: Costs and demand of high-speed rail in Italy and Spain. *Transport Policy*, 68, pp.63-79.
- [5] Census of India, Ministry of Home Affairs, Government of India, New Delhi, 2011. Available at: http://censusindia.gov.in/2011-prov-results/paper2/data_files/india/Rural_Urban_2011.pdf (Accessed: Nov 2018)
- [6] Davidson, W., Donnelly, R., Vovsha, P., Freedman, J., Ruegg, S., Hicks, J., Castiglione, J. and Picado, R., 2007. Synthesis of first practices and operational research approaches in activity-based travel demand modeling. *Transportation Research Part A: Policy and Practice*, 41(5), pp.464-488.
- [7] Delhi Metro Rail Corporation Ltd. (2016) , Available at: http://www.delhimetrorail.com/about_us.aspx#Introduction (Accessed: Nov 2018).
- [8] Delhi Metro Rail Corporation Ltd. (2017) Delhi Metro Annual Report, Available at: <Http://www.delhimetrorail.com/OtherDocuments/DMRCAEnglhYear20156.pdf>. (Accessed: Nov 2018).
- [9] Deloitte Haskins & Sells. (2015) Rapid metro rail Gurgaon limited: Financial statement 2014-15. Available at: http://www.itnlindia.com/application/web_directory/annual%20reports/2015/rapid%20metrorail%20gurgaon%20limite_d.pdf (Accessed: Sept 2018)

- [10] Flyvbjerg, B., 2007. Cost overruns and demand shortfalls in urban rail and other infrastructure. *Transportation Planning and Technology*, 30(1), pp.9-30.
- [11] Flyvbjerg, B., 2008. Public planning of mega-projects: overestimation of demand and underestimation of costs. *Decision-making on mega-projects: Cost-benefit analysis, planning, and innovation*, pp.120-44.
- [12] Flyvbjerg, B., Skamris Holm, M.K. and Buhl, S.L., 2005. How (in) accurate are demand forecasts in public works projects?: The case of transportation. *Journal of the American planning association*, 71(2), pp.131-146.
- [13] Fouracre, P., Dunkerley, C. and Gardner, G., 2003. Mass rapid transit systems for cities in the developing world. *Transport Reviews*, 23(3), pp.299-310.
- [14] Heilig, G.K., 2012. World Urbanization Prospects: The 2011 Revision. New York: United Nations, Department of Economic and Social Affairs (DESA), Population Division. *Population Estimates and Projections Section*.
- [15] IL&FS. (2012). Rapid Metro Rail project, a dream of millennium city, Gurgaon. Available at: <http://www.ilfsindia.com/projects.aspx?prid=20&catid=1&slnk=146&cid=5>. (Accessed: Nov 2018)
- [16] Kulkarni, D. and Shaikh, A. (2014). Kirit Somaiya wants CAG audit of Mumbai Metro loot. Available at: <http://www.dnaindia.com/mumbai/report-kirit-somaiya-wants-cag-audit-of-mumbai-metro-loot-1948456>. (Accessed: Nov 2018)
- [17] Kumar, A., The Hindu (2014) Rapid Metro ridership crosses 50 lakh in Delhi, Available at: <https://www.thehindu.com/news/cities/Delhi/rapid-metro-ridership-crosses-50-lakh-in-delhi/article6327838.ece> (Accessed: Oct 2018).
- [18] Medlock, K.B. and Soligo, R., 2002. Car ownership and economic development with forecasts to the year 2015. *Journal of Transport Economics and Policy (JTEP)*, 36(2), pp.163-188.
- [19] Metro Rail Kolkata (2015) Kolkata Metro - On a Reform Roadmap, Available at: http://www.mtp.indianrailways.gov.in/view_section.jsp?lang=0&id=0,1,283 (Accessed: Nov 2018).
- [20] Ministry of Urban Development (2017) *Centre to Support Metro Rails in Major Cities*, Available at: <http://www.pib.nic.in/newsite/erecontent.aspx?relid=87726> (Accessed: Oct 2018)
- [21] Mittal, Y.K. and Paul, V.K., 2018. Identification of Critical Factors for Delay in Metro Rail Projects in India. *International Journal of Students' Research in Technology & Management*, 6(1), pp.30-39.
- [22] Newman, P. and Kenworthy, J., 2015. The end of automobile dependence. In *The End of Automobile Dependence* (pp. 201-226). Island Press, Washington, DC.
- [23] Paulley, N., Balcombe, R., Mackett, R., Titheridge, H., Preston, J., Wardman, M., Shires, J. and White, P., 2006. The demand for public transport: The effects of fares, quality of service, income and car ownership. *Transport Policy*, 13(4), pp.295-306.
- [24] Press Information Bureau (2014) *Population norm for Metro Rail Projects to be reduced to 10 lakhs from the present 20 lakhs*, Available at: <http://pib.nic.in/newsite/mbErel.aspx?relid=108477> (Accessed: Nov 2018).
- [25] Ray, A. (2015). Metro misses September 2015 deadline. Available at: <http://timesofindia.indiatimes.com/city/bengaluru/Metro-misses-September-2015-deadline-delay-costs-BMRC-Rs-2-3-crore-a-day/articleshow/45723932.cms>. (Accessed: Sept 2018)
- [26] Reliance Mumbai Metro (2013) Available at: <http://www.reliancemumbaimetro.com/overview.html>. (Accessed: Sept 2018)
- [27] RITES Ltd. (2011). EIA for phase III corridors of Delhi Metro. Available at: <http://www.delhimetrorail.com/otherdocuments/EIAPhaseIII.pdf>. (Accessed: Oct 2018)
- [28] RMRGL-Rapid Metro Rail Gurgaon Limited (2015) Rapid Metro Rail Limited Annual Report 2013-14, Available at: <http://www.delhimetrorail.com/OtherDocuments/DMRCAEnglhYear20156.pdf>. (Accessed: Dec 2018)
- [29] Salling, K.B. and Leleur, S., 2015. Accounting for the inaccuracies in demand forecasts and construction cost estimations in transport project evaluation. *Transport Policy*, 38, pp.8-18.

- [30] Schafer, A. and Victor, D.G., 2000. The future mobility of the world population. *Transportation Research Part A: Policy and Practice*, 34(3), pp.171-205.
- [31] Skamris, M.K. and Flyvbjerg, B., 1997. Inaccuracy of traffic forecasts and cost estimates on large transport projects. *Transport policy*, 4(3), pp.141-146.
- [32] Un-Habitat, 2012. *State of the World's Cities 2008/9: Harmonious Cities*. Routledge.
- [33] World Bank (2012) Delhi Airport Metro Express, Available at: <http://documents.worldbank.org/curated/en/136791468267004838/pdf/NonAsciiFileName0.pdf> (Accessed: Sept 2018).

