

A review study on live construction of Bus depot at Ulhasnagar (Mumbai)

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Abstract—The live construction study of the Ulhasnagar Bus Depot in Mumbai Metropolitan Region (MMR) offers a valuable lens into the evolving dynamics of urban transport infrastructure under Smart City and MoHUA frameworks. This observational project focuses on the real-time execution, stakeholder coordination, and technical integration involved in developing a functional and sustainable bus depot. Ulhasnagar, a rapidly urbanizing node in Thane district, has witnessed increasing demand for organized public transport, prompting the Ulhasnagar Municipal Corporation (UMC) and Maharashtra State Road Transport Corporation (MSRTC) to initiate depot development aligned with regional mobility goals.

The study involved multiple site visits during active construction phases, enabling firsthand documentation of civil works, layout sequencing, and quality control practices. Key components observed included excavation, foundation casting, drainage alignment, bus bay configuration, and installation of electric charging infrastructure. The study also assessed quality control mechanisms such as material testing, inspection protocols, and documentation practices. Technical recommendations emerging from this study include the adoption of phased commissioning strategies, predictive maintenance frameworks, and bilingual documentation for institutional clarity. The depot's strategic location and design also present opportunities for multimodal integration with feeder services and last-mile connectivity enhancements.

In conclusion, the live construction study of the Ulhasnagar Bus Depot underscores the importance of aligning technical execution with policy mandates, stakeholder expectations, and urban mobility trends. It serves as a replicable model for similar infrastructure projects across Tier-II cities, advocating for data-driven planning, robust quality assurance, and inclusive design. The findings contribute to the broader discourse on sustainable transport infrastructure in India and reinforce the role of academic observation in bridging policy and practice.

Index Terms—Live Construction Monitoring, Multimodal Connectivity, Infrastructure Sustainability, Stakeholder Coordination, Quality Control Practices

I. INTRODUCTION

The rapid urbanization of the Mumbai Metropolitan Region (MMR) has necessitated a significant expansion and modernization of its public transportation infrastructure. The construction of new bus depots is a critical component of this strategy, serving as essential hubs for vehicle parking, maintenance, refueling, and administration. These facilities are complex undertakings, integrating civil, structural, mechanical, electrical, and plumbing systems on a large scale.

The live construction of the Ulhasnagar Bus Depot epitomizes the challenges inherent in such public projects. Executed in a densely populated urban environment, the project had to navigate tight site constraints, interface with existing infrastructure, and minimize disruption to surrounding communities. In this high-stakes context, the traditional paradigms of construction management are often stretched to their limits. The relentless pressure to maintain schedules can frequently come at the expense of financial control and quality standards, leading to a well-documented industry trend of cost overruns and quality deficiencies in public infrastructure projects.

This scenario underscores the paramount importance of deploying robust, integrated, and proactive project control mechanisms. Effective cost management ensures the judicious use of public funds, while rigorous quality control is non-negotiable for ensuring the structural integrity, safety, and longevity of the asset. Therefore, a forensic examination of how these mechanisms perform in a real-world, challenging project is not just an academic exercise but a practical necessity for improving future project outcomes.

Construction projects are traditionally divided into series of activities or operations undertaken by different individuals or groups who may have different levels of interest and or involvement in the project. Construction projects are generally unique in nature based on their fragmentation, processes and interaction with numerous parties; and just like any other venture, are constrained by time and resources (both human and material) which are needed for the projects. Therefore, the lengthy process of design and execution of construction projects constitutes a complex system which involves collaboration and negotiations among many stakeholders which may include but not limited to the clients, designers, contractors, local authorities and the general project environment. The different parties involved both directly and indirectly on the project are referred to as the project stakeholders whose management is vital to achieving project success. Stakeholder management therefore, has been recognized as an important strategy for achieving project success in construction projects.

Different stakeholders have different levels and types of investments and interests in the projects they are involved in. Stakeholders need to be managed and their power and influence mapped so that their potential impact on projects can be better understood. Stakeholders can be a key risk-management issue for project managers in construction organization and it is important to include them in the project plan. Various projects have viewed importance of Stakeholder Management in large construction projects and studies have been carried out on this topic. However, despite of much study in this area, construction projects have little record of how Stakeholder is managed in their organisations. Thus, only a few construction project organisations include stakeholders as an element in their project plan. Scholars have raised a number of reasons as the cause of problems and these include: lack of engagement in Stakeholder Management and the complexity and uncertainly of projects. They find that as each project is a unique undertaking with different stakeholders of different interests and powers. Other causes include 1) inadequate engagement of stakeholders 2) project managers having unclear objectives of stakeholder management 3) difficulty in identifying the invisible stakeholders and 4) inadequate communication with stakeholders. It is therefore crucial to understand the

methods and the critical success factors essential for the successful stakeholder management. The purpose of this study is to investigate the current methods for managing stakeholders in the literature and relate with the results of the multiple-case studies done in Stockholm region. The purpose is to provide examples that can be useful for construction project organisations in Stockholm. The aim is to encourage construction project organisations to proactively manage their stakeholders to avoid the negative impact of their actions on projects.

II. LITERATURE RIVIEW

Svejvig, P., & Andersen, P. (2015), for public-sector projects, the PRINCE2 (Projects IN Controlled Environments) methodology is also prominent, emphasizing business justification and staged management (AXELOS, 2017). However, the linear application of these frameworks in dynamic environments is often challenging. Svejvig and Andersen (2015) argue for a "rethinking" of project management, advocating for more agile and flexible approaches tailored to context. This is critical for live projects where uncertainty is high. [3][4]

Narbaev, T., & De Marco, A. (2014), the triple constraints of Time, Cost, and Quality are the primary measures of project performance. Earned Value Management (EVM) is a widely projected technique for integrated cost and schedule control. Project by Narbaev and De Marco (2014) and Kim et al. (2019) demonstrates the efficacy of EVM in predicting final project costs and diagnosing performance problems early, which is vital for preventing overruns in publicly funded projects. [5]

Thomas, S. R., Horman, M. J., Minchin, R. E., & Chen, D. (2015), the choice of structural system is a fundamental decision impacting all other project parameters. For depot-like structures requiring large column-free spans, the debate often centers on Conventional Reinforced Cement Concrete (RCC) frames versus Pre-Engineered Buildings (PEB).

Conventional RCC Framing: While offering flexibility in design and high perceived durability, RCC construction is often slower due to formwork, curing times, and weather dependency. Thomas et al. (2015) highlighted issues of time and cost overruns in RCC projects due to rework and material wastage. [6]

Ganapathi, K., Kishore, R., & Sharma, V. (2020), Pre-Engineered Buildings (PEB): PEBs, characterized by factory-fabricated steel members, are lauded for speed of erection. Jain et al. (2018) conducted a comparative study showing that PEBs can result in a 30-40% reduction in construction time compared to conventional methods. Furthermore, Ganapathi et al. (2020) emphasized the sustainability benefits of PEBs, including reduced material waste and potential for recycling. [7]

Patil, J. D., Vasanwala, S. A., & Solanki, C. H. (2017), the foundation design is another critical aspect, especially in the context of Mumbai's soft soil and high water table. Project on deep foundations, such as pile rafts, is highly relevant. Patil et al. (2017) and Sharma and Imam (2020) have studied innovative pile foundation techniques suitable for high-water table and low-bearing capacity soils, common in coastal regions. [8] [9]

Aaltonen, K., & Kujala, J. (2016), Stakeholder theory, pioneered by Freeman (1984), posits that managing relationships with all parties affected by a project is crucial for success. This is exponentially true for public infrastructure projects. Aaltonen and Kujala (2016) provide a comprehensive literature review of stakeholder management in projects, charting its evolution and highlighting strategies for classifying and engaging stakeholders. [10]

Leung, M. Y., Yu, J., & Liang, Q. (2014), In the context of urban "live" construction, the public and local communities become paramount stakeholders. Leung et al. (2014) discuss the social license to operate, arguing that community acceptance is a non-negotiable prerequisite for project success. Failure to manage this effectively can lead to protests, delays, and reputational damage, as documented by Osei-Kyei and Chan (2017) in their study of stakeholder management in Public-Private Partnerships (PPPs). [11][12]

Yang et al. (2016) developed a framework for improving communication among stakeholders in construction projects, identifying trust and transparency as key mediators. For dealing with conflicts, which are inevitable, Cheng et al. (2018) explored conflict resolution models, finding that collaborative approaches yield the most sustainable outcomes. [13]

Zou et al. (2014) live construction in urban areas is fraught with unique risks. Provided a systematic

review of risk management in construction, categorizing risks into technical, managerial, economic, and political/social. The latter two are particularly acute in Indian public projects. [14]

Deb et al. (2019) studied the impact of weather delays on construction schedules and proposed robust scheduling models that incorporate weather-related risk buffers. Furthermore, site logistics in congested areas is a major challenge. The monsoon season presents a significant external risk. [15]

Agyekum-Mensah et al. (2017) emphasized the role of 4D BIM for site layout planning and logistics management to minimize conflicts and improve safety in constrained sites. [16]

Boton et al. (2021), Building Information Modeling (BIM) transcends 3D modeling to become a powerful project management tool. Sacks et al. (2018) demonstrated how BIM facilitates better coordination, clash detection, and quantity take-offs. Specifically explored the use of 4D (time) and 5D (cost) BIM for visualizing construction sequences and integrating cost data, which is invaluable for planning complex, phased constructions. [17][18]

Lu et al. (2023), demonstrate how Building Information Modeling (BIM) evolves into IDD, creating a digital twin that integrates design, fabrication, and construction, significantly reducing information loss and rework. This is crucial for a depot with complex MEP systems. [19]

Salem et al. (2016) and Bajjou et al. (2018) provided evidence that techniques like the Last Planner System® improve workflow reliability and reduce project durations. Lean Construction principles, derived from the Toyota Production System, aim to eliminate waste and maximize value. [20][21]

Li et al. (2014) and Wuni and Shen (2020) reviewed the critical success factors for prefabricated construction, highlighting design standardization, supply chain integration, and skilled erection crews as vital components. The integration of prefabrication, a component of PEBs, is a key lean strategy. Propose a machine learning-enhanced EVM model that provides more accurate forecasts of final project cost and schedule performance by analyzing historical data and real-time progress, offering a powerful tool for controlling public expenditure. [22]

Ogunlana et al. (2022), introduce a resilience-based scheduling framework that builds in buffers and adaptive response strategies for external shocks like

monsoon rains or supply chain disruptions, a critical consideration for Mumbai's climate. [23]

McHugh, K., Patel, V., & Dave, B. (2021), provide evidence from Indian case studies where the application of the Last Planner System® (LPS) improved workflow reliability and reduced project durations by over 15% by enhancing crew commitment and identifying constraints in advance. [24]

Chen, H., Mao, Y., Xu, Y., & Wang, R. (2023), review the application of IoT sensors, wearables, and computer vision for proactive safety management on congested sites, directly addressing the high-risk nature of live construction adjacent to public areas. [25]

Sharma & Patel (2024), concludes that while initial material costs can be comparable, PEBs offer 40-50% faster erection times and a lower environmental footprint due to reduced site waste and water usage, making them highly suitable for time-bound public projects. [26]

Wuni & Shen (2023), identify critical success factors for MiC, emphasizing the need for early stakeholder involvement in design freeze and robust logistics planning for transporting large modules through crowded urban streets—a key insight for depot admin block construction. [22]

Bock (2024), discusses the emerging role of robotics in structural erection and finishing works, highlighting their potential to improve quality, speed, and safety in repetitive tasks, though noting the current investment barriers in the Indian context. [27]

Ding et al. (2023), analyze the implementation of renewable energy integration (e.g., solar canopies), rainwater harvesting, and pervious pavements in transportation hubs, linking them not only to environmental goals but also to long-term operational cost savings. [28]

Aaltonen et al. (2021), present a dynamic mapping tool that helps project managers identify and prioritize stakeholders based on their evolving power, legitimacy, and urgency, preventing last-minute conflicts. [29]

Liu et al. (2022), explore the use of social media, dedicated project apps, and interactive web portals to provide real-time updates, receive grievances, and build trust with the community, mitigating the "not-in-my-backyard" (NIMBY) syndrome. [19]

Cheng & Kumar (2023), developed a model for construction dispute resolution that prioritizes mediation and negotiation over litigation, preserving relationships and avoiding costly delays, which is essential for dealing with multiple public agencies. [30]

Mathur (2020), argues for mandatory and continuous SIA throughout the project lifecycle, not just at the feasibility stage, to monitor and mitigate negative impacts like traffic congestion, dust, and noise on local residents. [31]

Zhao & Feng (2024), link strategic Corporate Social Responsibility (CSR) initiatives undertaken during construction (e.g., skill development for local youth, improving local infrastructure) with gaining community acceptance and creating a positive project legacy. [32]

Liu et al. (2022) investigated the role of social media as a platform for stakeholder engagement in megaprojects. Their framework suggested that transparent, real-time communication through social media builds trust, reduces resistance, and enhances public perception of construction projects. By analyzing case studies of large-scale infrastructure initiatives, they showed how social media helped mitigate conflicts and mobilize public support. For the Ulhasnagar Bus Depot, which directly affects commuters, local vendors, and residents, employing social media platforms could be an effective strategy for disseminating updates, addressing public concerns, and fostering a sense of community involvement in the project's progress. [38]

Lu et al. (2023), introduced the concept of Integrated Digital Delivery (IDD), which integrates Building Information Modeling (BIM), IoT, and cloud platforms across the lifecycle of a built asset. Their study demonstrated that IDD improves collaboration, eliminates duplication of data, and enhances sustainability by ensuring accurate and real-time information sharing among stakeholders. Case studies confirmed its effectiveness in coordinating multidisciplinary teams. In the Ulhasnagar Bus Depot, adopting IDD would provide a unified digital environment where designers, engineers, contractors, and authorities collaborate seamlessly, thereby minimizing design errors, accelerating approvals, and ensuring smoother construction and long-term operations. [39]

Mathur (2020), emphasized the importance of Social Impact Assessment (SIA) as a tool for inclusive development in infrastructure projects. The paper argued that infrastructure development often displaces communities, disrupts livelihoods, or alters social dynamics, and thus requires careful assessment of social consequences. By reviewing Indian case studies, Mathur highlighted how SIAs foster dialogue, ensure fair compensation, and improve community acceptance. For the Ulhasnagar Bus Depot, this framework is vital since the project may affect street vendors, nearby residents, and informal businesses. Conducting a thorough SIA would ensure that affected groups are not marginalized, reducing the likelihood of protests or legal challenges. [40]

Mehta and Krishnan (2022), reviewed various ground improvement techniques for construction in areas with high water tables, a common challenge in coastal and low-lying regions of India. Their study compared the performance of methods such as vibro-compaction, stone columns, preloading, and grouting, assessing them based on cost, applicability, and long-term stability. They concluded that the choice of method must be site-specific, guided by geotechnical investigations and environmental considerations. The findings are particularly relevant to the Ulhasnagar Bus Depot, where waterlogging and soil stability are potential risks. Employing appropriate soil stabilization strategies would ensure safe foundation conditions, prolonging the structural life of the depot. [41]

Aaltonen, K., & Kujala, J. (2016), Investigate stakeholder dynamics by synthesizing empirical evidence on how stakeholders' salience and roles change across project phases. Using longitudinal case material and conceptual analysis, they emphasize that stakeholder salience is contingent, shaped by both formal power structures and emergent situational factors (e.g., regulatory decisions, public reactions). The authors argue for procession stakeholder management—continuous mapping, adaptive engagement tactics, and institutionalized escalation paths—rather than one-off stakeholder analyses. For the Ulhasnagar Bus Depot, their work underscores the need for iterative stakeholder mapping and flexible engagement mechanisms (especially for utilities and community actors) as the project moves from civil works to operational handover. [42]

III. RESEARCH GAP

This project while the existing literature offers robust principles for cost control, quality management, and project planning, along with numerous infrastructure case studies, a significant gap remains in their contextualized and integrated application to live public bus depot construction within India's unique urban setting. This project specifically addresses the scarcity of combined forensic evaluations of cost and quality mechanisms under live site pressures, the absence of a management-centric Bill of Quantities (BOQ) developed through a Work Breakdown Structure (WBS) framework, and the lack of empirical, context-specific frameworks for public infrastructure projects in India. By integrating these critical dimensions and moving beyond generic models, this study aims to provide a holistic, analytically rigorous evaluation that generates tailored best practices for enhancing project delivery in the Indian construction ecosystem.

This was presented in a table by the authors and stakeholder involvement and feedback mechanisms have been added to the factors under communication. The need for constant cash flow cannot be overemphasized but it needs to be balanced with adequate efforts and leadership in terms of continuing involvement of the project stakeholders to ensure proper control and support. The component of competence emphasizes the need for capable manpower to carry out all the tasks involved in the project if success is to be attained at the end of the project. The component of commitment points out that all project stakeholders should be interested in the goals of the project. Lastly, an effective communication system is required and is essential to ensure good decision and integration throughout the project. The modifications made to the four COMs are in the “competence” component in which adopting the right procurement route is introduced and in the “communication” component in which community involvement is changed to community/stakeholder involvement and feedback mechanism is introduced.

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