Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 6, No.3, June : 2025

FEASIBILITY MANAGEMENT AND MAINTENANCE IN HIGHWAY CONSTRUCTION ZONE

Mr. Onkar sudhir Dhere PG Student, Depatment of civil Engineering, Ashokrao Mane Group of Institution Vathar, Dr.Babasaheb Ambedkar technological university lonere, Maharashtra Email-onkardhere16@gmail.com
Mr. Jayant A. Patil Assistant Professor, Department of Civil Engineering, Ashokrao Mane Group of Institutions, Vathar, Dr.Babasaheb Ambedkar technological university lonere, Maharashtra Mail id: jap@amgoi.edu.in

Abstract
Highway construction and maintenance are crucial for ensuring public safety, economic growth, and effective transportation infrastructure. Effective feasibility management and maintenance of highway construction zones are essential for successful project outcomes and long-term infrastructure sustainability. Construction zones are dynamic environments that require managing various factors, including cost, time, environmental impact, and resource availability. Efficient maintenance ensures that the constructed roadways perform optimally, reduce potential hazards, and meet evolving transportation needs. This study focuses on the complexities of feasibility management and maintenance in highway construction zones, emphasizing the need for strategic approaches that balance stakeholder expectations, project requirements, and environmental concerns. It also highlights best practices, challenges, and innovative solutions in managing these areas. By examining case studies and exploring cutting-edge technologies, this research aims to offer practical insights into improving highway construction efficiency and sustainability. The findings emphasize the importance of developing a comprehensive framework for feasibility management and maintenance strategies to optimize investment returns. Ultimately, this study advocates for collaborative efforts, modern technologies, and sustainable practices to ensure the creation of safe, efficient, and long-lasting transportation infrastructure.

Keywords:
Highway construction, feasibility management, maintenance, infrastructure sustainability, environmental impact, safety.

I. INTRODUCTION

Highway building and upkeep are vital projects that have a big influence on public safety, economic growth, and transportation infrastructure. The management of feasibility and upkeep of highway construction zones become essential components of guaranteeing successful project results and long-term infrastructure sustainability as the need for effective and sustainable transportation networks grows. Highway construction zones are dynamic settings where complicated construction tasks are carried out, temporary diversions are implemented, and traffic flow is constantly changing. In order to manage the profitability and practicality of planned highway building efforts, many elements are taken into account, including cost, time, environmental effect, and resource availability[1]. At the same time, maintenance plans are essential to maintaining the built-in roadways' lifetime, safety, and functioning. The below figure illustrates the process of road grading construction, involving leveling and shaping the ground surface for road development.

Industrial Engineering Journal
ISSN: 0970-2555
Volume : 54, Issue 6, No.3, June : 2025

Fig 1. Road Grading construction

As per the above figure Fig 1. depicts the process of building a road. It likely shows construction equipment, such as graders and excavators, working on a designated path for the new road. The existing landscape, with hills and valleys, is also visible. Piles of dirt or gravel might be scattered around the site, designated for either filling in low areas or removing excess soil from high points.

This issue explores the many facets of feasibility management and maintenance in highway construction zones, including the methods, best practices, and obstacles that these procedures must overcome. Highway construction zones are dynamic environments that need a strategic approach to feasibility evaluations that balance stakeholder expectations, project requirements, and environmental concerns. Furthermore, efficient maintenance procedures are necessary to guarantee that the built roadways maintain performance standards, reduce possible hazards, and satisfy changing transportation requirements. Maintenance methods are essential for optimizing the return on investment for highway building projects, from regular upkeep to handling unanticipated challenges.

This investigation will traverse the complexities of feasibility management and upkeep in highway building zones, illuminating creative methods, cutting-edge developments in technology, and cooperative endeavors that support the prosperity and long-term viability of transportation infrastructure. Understanding and optimizing the maintenance and feasibility elements of highway construction is critical to developing robust, efficient, and long-lasting transportation networks as the transportation environment continues to change. Highway building and upkeep are vital projects that have a big influence on public safety, economic growth, and transportation infrastructure. The management of feasibility and upkeep of highway construction zones become essential components of guaranteeing successful project results and long-term infrastructure sustainability as the need for effective and sustainable transportation networks grows[3].

1.2 The Crucial Role of Highways

Highways are the backbone of transportation infrastructure, playing a pivotal role in connecting communities, facilitating commerce, and driving economic development. These arterial roadways form an extensive network that spans regions and nations, serving as essential conduits for the movement of people and goods. The critical functions of highways are deeply intertwined with various aspects of daily life, commerce, and societal progress.

1. **Connectivity:** Highways serve as vital links, connecting cities, towns, and rural areas, fostering regional integration and accessibility. This interconnected network enhances mobility, allowing individuals to travel seamlessly between locations for work, education, healthcare, and leisure.

The above figure depicts various elements and components of highway infrastructures, including roads, bridges, interchanges, and traffic control systems.

Fig 2. Highway infrastructures

Above Figure illustrates a highway construction zone with multiple lanes and traffic flowing in both directions. Traffic cones and barriers ensure safety by guiding vehicles and protecting workers. Directional signs assist navigation, while the construction equipment indicates ongoing maintenance or upgrades to improve road capacity and safety.

2. **Economic Development**: Highways are catalysts for economic growth, providing efficient transportation routes for the movement of goods and services. Accessible and well-maintained highways contribute to the expansion of trade, the establishment of businesses, and the creation of employment opportunities, thereby driving economic prosperity[4].

3. **Commerce and Trade:** The efficient flow of goods relies heavily on highways for the transportation of raw materials, finished products, and supplies. Highways connect industrial centers, ports, and distribution hubs, facilitating the smooth movement of goods across local, regional, and national markets.

4. **Accessibility and Social Integration:** Highways promote social inclusivity by connecting remote areas to urban centers, ensuring that people from diverse backgrounds have access to essential services, education, and healthcare. This enhanced accessibility fosters a more integrated and cohesive society[4].

5. **Emergency Response**: Highways play a critical role in emergency response, providing swift routes for the movement of emergency services, ambulances, and disaster relief teams. Rapid and reliable transportation along highways is essential during natural disasters, accidents, or public emergencies.

6. **Tourism and Recreation**: Scenic highways contribute to tourism and recreation, attracting travelers with picturesque landscapes, historical sites, and cultural landmarks. Highways create opportunities for tourism-related businesses and contribute to local economies[4]

7. **Technological Integration:** Highways are at the forefront of technological integration, incorporating smart transportation systems, intelligent traffic management, and digital infrastructure. These advancements improve safety, efficiency, and sustainability in highway operations.

1.3 Objective of Study

1. To evaluate current feasibility management practices.
2. To assess environmental and safety implications in highway construction zone.
3. To develop a framework for feasibility management.
4. To analyze maintenance strategies for long-term sustainability.

II. LITERATURE REVIEW

Sepehr Sabeti (2021): This study discusses the integration of AI and AR to enhance highway work zone safety, addressing fatal accidents. Using edge-based AI, real-time wireless communication, and AR alerts, results show excellent performance in vehicle detection and worker safety, with positive worker feedback. Gaoru Zhu (2020): Evaluating highway construction feasibility in eco-sensitive regions of Western China using AHP and expert scoring, this study assesses construction necessity and ecological friendliness. Results indicate varying feasibility scores for planned highways, aiding regional planning and transportation route optimization. Ahmed Jalil Al-Bayati (2023): This study reviews U.S. highway work zone safety, focusing on internal-source and vehicle intrusion incidents. It emphasizes the importance of Internal Traffic Control Plans (ITCPs), recommending their enforcement by OSHA to improve roadwork safety and reduce fatalities and injuries. Yuanyuan Liu (2022): Analyzing CO2 emissions from traffic delays during highway maintenance, this study uses life cycle assessment methods. Findings reveal that preventive maintenance contributes significantly to CO2 emissions, with strategies like limiting traffic volume and adjusting work zone speeds offering the most effective mitigation.

Pratiksha R. Patil (2020): Using the HDM-4 model, this research assesses the economic feasibility of highway improvements between Mumbai and Pune. The analysis of traffic conditions and investment shows that widening the highway is economically viable, supporting infrastructure development for long-term economic growth. Gulnara A. Gareeva (2020): This study focuses on technical and

economic planning in road construction using a financial information system. It identifies key economic benefits from improved order distribution systems, offering an economic benefit of 2237.03 rubles annually, enhancing management efficiency. Fei Shan (2021): This research uses activity-based costing to analyze labor and material costs in rural highway projects. Findings emphasize the importance of cost control in rural road maintenance, suggesting improvements to local road management systems for better operational efficiency. Haniffan D. Baihaqi (2023): The study uses multi-criteria Analysis to prioritize road handling based on technical and economic factors. Findings reveal significant differences in daily traffic, road conditions, and economic values, providing a structured approach for optimizing road management in East Java. Anna Kharchenko (2022): This research develops a conceptual model to optimize cost and project duration in road maintenance using the "silver triangle" theory. The model integrates pre-project quality indicators and multiple optimization strategies, enhancing efficiency in long-term road maintenance planning.

Zhenghong Peng (2022): This study explores cost management in highway engineering, focusing on the list pricing model's effectiveness. By analyzing the model's advantages and challenges, it offers insights into improving cost control in highway construction projects, emphasizing professional supervision and risk management. J. Skovajsa (2022): Investigating a mobile traffic management system during roadwork in the Czech Republic, this study presents before-and-after data showing a 20% increase in roadwork zone capacity and a 30-second reduction in vehicle delays, supporting the system's effectiveness for traffic flow improvement. Ying Wang (2021): This study proposes a fuzzy maintenance evaluation method for highway safety using gray correlation. The model evaluates various highway components, providing decision-makers with a tool to assess maintenance needs and prioritize repairs to improve road safety management.

Table 1. Literature survey

References	Topic Name	Method	Findings
M. Durga (2020)	Traffic Congestion in Bangalore, India	Analysis of traffic congestion and potential solutions (flyovers, ring roads)	Need for improved infrastructure and traffic management to reduce congestion and improve transport efficiency.
Gugilla Aruna (2003)	Integrated Management Model for Work Zone Optimization	Optimization methods like Powells and Simulated Annealing algorithms	Reduction of costs and improved traffic flow by optimizing work zone characteristics using advanced algorithms.
Saleh M. Alsultan (2022)	Road Work Zone Safety in Saudi Arabia	Survey data to identify key risks, including driver behavior	Key crash risks identified, including driver behavior, with recommendations for stricter enforcement to improve safety.
Tejas Pawar (2021)	Feasibility of Green Roads Using Plastic Waste Technology	Lifecycle analysis comparing green roads with conventional roads	Green roads are economically viable in the long term, offering reduced maintenance and repair costs despite higher initial costs.
Abdel-Rahman Megahid (2020)	Utilization of Industrial Waste in Highway Construction	Investigating the use of fly ash and silica fume in bituminous mixes	Incorporation of industrial waste materials improves bituminous mixes, increasing stability and promoting sustainability.

Lu Lv (2021)	Impact of Median Width on Work Zone Crossovers	Driving simulations to analyze the impact of median widths on driving behavior	Adjusting median widths for work zone crossovers optimizes vehicle control and enhances safety during highway reconstruction.
Jingyu Li (2022)	Maintenance Strategies for Highway Bridges in China	Review of common problems and strategies for bridge maintenance	Challenges in highway bridge construction identified, with proposed solutions for more effective and safer bridge maintenance.
Qingguo Chang (2023)	Optimization of Electromechanical Facility Management in Highway Tunnels	Development of strategies for optimizing tunnel electromechanical management	Predictive maintenance and continuous monitoring enhance the safety, operational reliability, and longevity of tunnel infrastructure.

III. RESEARCH METHODOLOGY

The research methodology involves reviewing relevant literature on feasibility management and maintenance challenges in highway construction zones. A case study analysis is conducted, followed by Life Cycle Cost Analysis (LCCA) of road construction. Data collection techniques include surveys, traffic analysis, and observational studies. The findings are interpreted to develop effective feasibility management strategies and long-term maintenance plans for highway infrastructure sustainability.

CONCLUSION

In conclusion, effective feasibility management and maintenance in highway construction zones are crucial for the sustainability and safety of transportation infrastructure. As construction zones often face complex challenges, including fluctuating traffic flow, environmental concerns, and resource limitations, it is essential to establish a comprehensive approach that balances these factors. This study highlights the significance of feasibility evaluations that consider the technical, economic, and environmental impacts of construction projects. Furthermore, maintenance strategies are vital in ensuring that constructed roads retain their functionality and safety over time, offering optimal returns on investment. The research identifies that current practices in highway construction and maintenance often fall short in addressing these complex challenges. It emphasizes the need for integrating modern technologies and collaborative efforts to streamline the planning, execution, and upkeep of highway infrastructure. The study also sheds light on the importance of developing frameworks that align with sustainability goals, ensuring that highways meet evolving transportation needs while minimizing adverse effects on the environment. In the face of growing infrastructure demands, the paper underscores the necessity of adopting innovative management practices to improve the efficiency, safety, and longevity of highway construction projects. These improvements will provide long-term benefits to the public, economy, and the environment.

FUTURE SCOPE

The future scope of research in highway construction feasibility management and maintenance lies in exploring advanced technologies and strategies that enhance project efficiency and sustainability. The integration of artificial intelligence (AI), machine learning, and Internet of Things (IoT) can revolutionize the monitoring, prediction, and management of construction and maintenance activities. Research into the environmental impact of construction materials and techniques will also be pivotal, promoting the adoption of sustainable practices, such as the use of recycled materials and eco-friendly designs. Additionally, the role of smart transportation systems and automated traffic management can

optimize traffic flow and reduce congestion in construction zones, improving safety and reducing delays. Future studies could also focus on developing more precise life cycle cost analysis models that incorporate long-term maintenance and operational factors. Exploring global best practices and case studies will offer valuable insights into effective, scalable solutions. Ultimately, the future of highway construction and maintenance management should focus on integrating innovation, sustainability, and technology to build safer, more efficient, and environmentally friendly road networks.

REFERENCES

1. A. D. Yadav, A. Prof, A. Varsha, K. Kumar, and M. P. U. Planning, "Sustainability in Highway Projects : A Concise Review," pp. 987–992, 2022.
2. A. J. Al-Bayati, "Managing Work Zone Safety during Road Maintenance and Construction Activities: Challenges and Opportunities." 2023. [Online]. Available: https://trid.trb.org/view/2072101
3. A. R. Radzi, "Decision making in highway construction : a systematic review and future directions," no. September, 2021, doi: 10.1108/JEDT-06-2021-0306.
4. A. Z. Abdelmohsen, M. Asce, K. El-rayes, and M. Asce, "Optimizing the Planning of Highway Work Zones to Maximize Safety and Mobility," no. November, 2017, doi: 10.1061/(ASCE)ME.1943-5479.0000570.
5. A.-R. Megahid, H. Younis, T. Abdel-Wahed, and E. Abdel-Sabour, "Utilization of Industrial Waste Material in Highway Construction," *JES. J. Eng. Sci.*, vol. 48, no. 2, pp. 373–382, 2020, doi: 10.21608/jesaun.2020.107604.
6. B. Du and S. Chien, "Feasibility of shoulder use for highway work zone optimization Feasibility of shoulder use for highway work zone optimization," vol. 7564, no. August 2014, 2015, doi: 10.1016/S2095-7564(15)30269-5.
7. C. R. Huebschman, "Construction Work Zone Safety." 2003. [Online]. Available: https://docs.lib.purdue.edu/jtrp/43/
8. F. Shan, "Research on Rural Highway Project Construction Management and Maintenance," *Proc. Bus. Econ. Stud.*, vol. 4, no. 4, pp. 178–185, 2021, doi: 10.26689/pbes.v4i4.2422.
9. F. Shan, "Research on Rural Highway Project Construction Management and Maintenance," *Proc. Bus. Econ. Stud.*, vol. 4, no. 4, pp. 178–185, 2021, doi: 10.26689/pbes.v4i4.2422.
10. G. A. Gareeva, D. R. Grigoreva, and I. I. Mahmutov, "The Process of Management and Control of Feasibility Planning of Road Construction Using the Financial Information System," *Int. J. Financ. Res.*, vol. 12, no. 1, p. 184, 2020, doi: 10.5430/ijfr.v12n1p184.
11. G. ARUNA, "Integrated Management of Highway Maintenance And Traffic," *Dep. Civ. Environmetal Eng*, vol. 8, no. 2, pp. 337–345, 2003.
12. G. Zhu et al., "Feasibility study of highway project in the environment sensitive area of Western China -- Based on the magic cube model of construction necessity and ecological friendliness," vol. 02023, 2020.
13. H. Ceylan, A Feasibility Study on Embedded Sensors and Systems (MEMS) for Monitoring Highway Structures, no. June. 2011.
14. H. D. Baihaqi and C. A. Prastyanto, "Analysis of Determining Priority of Road Handling Program in the Region of Kediri Road and Bridge Management Department of Highways East Java Province Using Multi Criteria Analysis (Mca) Method," *J. Civ. Eng.*, vol. 38, no. 1, p. 16, 2023, doi: 10.12962/j20861206.v38i1.15972.
15. H. Lord, "Highway Code: road rules." 2022. [Online]. Available: https://demo.tagdiv.com/newspaper_chained_news_pro/2022/03/24/td-post-highway-code-everything-you-need-to-know-as-road-rules-change-from-today-check-the-new-restrictions/
16. I. C. MEDINA, "Geographic Information System Applications in the Heart of Illinois Highway Feasibility Study." 1995. [Online]. Available: https://trid.trb.org/View/452724

17. I. M. FAKUDZE, "Feasibility Study To Determine The Potential For The Privatization Of Routine Road Maintenance In Swaziland," no. November, 2005.
18. J. Angara, "Wireless Sensors for Concrete Temperature Monitoring." 2021. [Online]. Available: https://www.akcp.com/blog/wireless-temperature-sensors-for-concrete-curing/
19. J. Skovajsa, O. Přibyl, P. Přibyl, M. Ščerba, and A. Janota, "Evaluation of a Mobile Highway Management System at Roadwork Zones," *Int. J. Eng. Trans. B Appl.*, vol. 35, no. 5, pp. 900–907, 2022, doi: 10.5829/ije.2022.35.05b.06.
20. K. B. Salling and D. Banister, "Feasibility risk assessment of transport infrastructure projects: The CBA-DK decision support model," *Eur. J. Transp. Infrastruct. Res.*, vol. 10, no. 1, pp. 103–120, 2010, doi: 10.18757/ejtir.2010.10.1.2871.
21. L. Lv, Y. Sheng, C. Song, Y. Li, and Z. Guo, "Driving Safety Assurance Method in Work Zone Crossovers of Highway Reconstruction and Expansion Project," *J. Adv. Transp.*, vol. 2021, 2021, doi: 10.1155/2021/5708779.
22. M. Bhanushali, "Application of Artificial Neural Network (ANN) Methodology in Conducting Life Cycle Cost Analysis (LCCA) For Roads," *Int. J. Innov. Res. Sci. Eng. Technol.*, vol. 13, no. 4, 2024, doi: 10.15680/IJIRSET.2024.1304298.
23. M. Durga, A. Shanmuganathan, and P. Srivastava, "Evaluating the feasibility of different approaches to decrease road traffic congestion in India," *Int. J. Adv. Res. Eng. Technol.*, vol. 11, no. 5, pp. 34–43, 2020, doi: 10.34218/IJARET.11.5.2020.005.
24. M. J. Markow, "Feasibility Study Of Changes To The Highway Maintenance And Operations Cost Index." 1999. [Online]. Available: https://trid.trb.org/view/348902
25. Pratiksha Patil, "Economic Feasibility Analysis of Highway Project using Highway Development and Management (HDM-4) Model," *Int. J. Eng. Res.*, vol. V9, no. 07, pp. 1042–1045, 2020.
26. Q. Chang, X. Chen, Q. Kuang, and Z. Chen, "Research on Maintenance and Management Optimization of Electromechanical Facilities in Highway Tunnel," *Acad. J. Sci. Technol.*, vol. 5, no. 3, pp. 169–171, 2023, doi: 10.54097/ajst.v5i3.8008.
27. Q. Jin and J. Li, "Common Problems and Maintenance Management of Highway Bridges," *J. World Archit.*, vol. 6, no. 6, pp. 29–34, 2022, doi: 10.26689/jwa.v6i6.4540.
28. S. M. Alsultan, F. K. Alqahtani, and K. F. Alkahtani, "Health and Safety in Temporary Work Zone Road Construction Project in Saudi Arabia: Risks and Solutions," *Int. J. Environ. Res. Public Health*, vol. 19, no. 17, 2022, doi: 10.3390/ijerph191710627.
29. S. Nepali, S. S. Bohara, N. Lama, and R. Rabin Thapa, "Assessment of Traffic Characteristic at Major Urban Road Intersection of Kathmandu Valley: A Case Study of Khanivivag, Kesarmahal, and Narayanhiti Intersections," *J. Civ. Constr. Eng.*, vol. 10, no. 1, pp. 22–31, 2024, doi: 10.46610/jocce.2024.v010i01.003.
30. T. Pawar and H. Ambre, "Feasibility Study of Green Road over Conventional Road," *Int. Res. J. Eng. Technol.*, no. July, 2021, [Online]. Available: www.irjet.net
31. Y. Kumar, "Role Of National Highways In Economic Development Of India," vol. 10, no. 4, pp. 19–29, 2022, [Online]. Available: https://ijcrt.org/papers/IJCRT2204685.pdf
32. Y. Liu, X. Zhu, X. Wang, Y. Wang, Q. Yu, and S. Han, "The Influence of Work Zone Management on User Carbon Dioxide Emissions in Life Cycle Assessment on Highway Pavement Maintenance," *Adv. Meteorol.*, vol. 2022, 2022, doi: 10.1155/2022/1993564.
33. Y. Wang and Y. Chen, "Evaluation Method of Traffic Safety Maintenance of High-Grade Highway," *Appl. Math. Nonlinear Sci.*, vol. 6, no. 1, pp. 65–79, 2021, doi: 10.2478/amns.2021.1.00007