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AI Driven Sustainable Project Management In High Speed Rail Infrastructure: Exploring AI Potential In Whoosh Indonesia

Nur Khofifah Qholidatuzia[1]*

[1]Universitas Islam Indonesia, Indonesia

*Corresponding Author: 25911006@students.uii.ac.id

ABSTRACT

The rapid development of Artificial Intelligence (AI) has significantly transformed the management of sustainable transportation infrastructure, particularly High-Speed Rail (HSR), by improving operational efficiency, asset management, and long-term sustainability. Sustainability has become a key priority in the development of large-scale transportation infrastructure. As the first high-speed rail project in Indonesia, Whoosh represents a significant milestone in the modernization of national transportation while highlighting the importance of Sustainable Project Management (SPM). This study aims to explore the potential role of Artificial Intelligence in strengthening Sustainable Project Management within High-Speed Rail infrastructure by using the Whoosh Indonesia project as a contextual case study. A narrative literature review was employed by collecting secondary data from academic journals, government reports, industry publications, official company reports, and other relevant literature related to Artificial Intelligence, Sustainable Project Management, and High-Speed Rail. The collected literature was analyzed thematically to identify the potential contributions of AI in supporting sustainable project management. The findings indicate that Artificial Intelligence has considerable potential to strengthen Sustainable Project Management through predictive maintenance, digital twin technology, intelligent traffic control, and smart operational platforms. These technologies improve operational efficiency, asset reliability, safety, and sustainability performance while supporting data-driven decision-making and more effective resource utilization. Overall, this study concludes that Artificial Intelligence can serve as a strategic enabler of Sustainable Project Management, making it highly relevant for enhancing the long-term sustainability and operational resilience of the Whoosh Indonesia project as well as other High-Speed Rail systems in developing countries.

Keywords: Artificial Intelligence, Sustainable Project Management, High-Speed Rail, Sustainable Transportation Infrastructure, Whoosh Indonesia.

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Introduction

The Transportation Sector is one of the important sectors in supporting economic growth, enhancing community mobility, and promoting sustainable development. Salah satu moda transportasi massal dengan tingkat efisiensi yang tinggi adalah kereta api karena kemampuannya untuk mengangkut

penumpang dalam jumlah besar sambil secara bersamaan mengurangi potensi kemacetan di koridor darat. (Agustiranti et al., 2024). Along with the development of global transportation technology, Indonesia is introducing High-Speed Rail (HSR) as a modern transportation innovation that supports mobility efficiency and sustainable transportation development.

Whoosh is a high-speed train service operated by PT Kereta Cepat Indonesia China (KCIC) that connects Jakarta with Bandung. This system is designed to improve travel time efficiency, reduce traffic congestion on conventional routes, and strengthen inter-regional connectivity that supports economic growth. Since its inauguration on October 2, 2023, Whoosh has made history as the first high-speed rail network in Indonesia and Southeast Asia. (PT Kereta Cepat Indonesia China, n.d.). As a National Strategic Project, Whoosh not only represents the modernization of Indonesian transportation but also becomes part of more sustainable infrastructure development.

The success of infrastructure development is not only measured by the achievement of cost, time, and quality of the project, but also by its ability to create sustainable economic, social, and environmental benefits. That perspective aligns with the concept of Sustainable Project Management (SPM), which integrates sustainability dimensions into the entire project life cycle. (Michaelides et al., 2014).

As the complexity of building and operating high-speed rail infrastructure increases, Artificial Intelligence (AI) is beginning to be utilized to support more effective project and operational management thru technologies such as Predictive Maintenance, Digital Twin, Intelligent Traffic Management, and real-time data analysis, thereby enhancing asset reliability, operational efficiency, and decision-making support (Olcay Özge Ersöz et al., 2022).

Although research on the application of Artificial Intelligence (AI) in High-Speed Rail (HSR) systems continues to develop, most studies still focus on technical aspects, such as predictive maintenance, infrastructure damage detection, operational optimization, and train traffic control. These studies show that AI is capable of improving the operational efficiency and reliability of railroad systems. However, studies linking the use of AI with Sustainable Project Management (SPM) are still relatively limited. However, AI has the potential to support the achievement of project sustainability goals thru increased resource efficiency, asset reliability, operational safety, and data-driven decision-making throughout the project lifecycle.

The limitations of this research become more apparent in the context of developing countries, particularly Indonesia, where studies on the potential of AI to enhance the sustainability of High-Speed Rail projects using Whoosh as the research context are still very few. Therefore, this research aims to explore the potential role of Artificial Intelligence in supporting Sustainable Project Management in the High-Speed Rail project using Whoosh Indonesia as a contextual case study. Specifically, this research addresses two research questions: (1) How does the Whoosh project reflect the principles of Sustainable Project Management? and (2) How can Artificial Intelligence potentially enhance Sustainable Project Management in the Whoosh High-Speed Rail project?

Literature Review

Sustainable Project Management

Sustainable Project Management (SPM) is a project management approach that integrates sustainability principles by considering economic, social, and environmental aspects throughout the entire project life cycle. In addition to being based on the Triple Bottom Line (TBL) concept, SPM also emphasizes the importance of transparency, accountability, risk management, stakeholder engagement, and the creation of long-term value for all parties affected by the project (Soares et al., 2024).

In the perspective of Sustainability Project Management, the success of a large-scale infrastructure project is no longer measured solely based on financial indicators. Project evaluation also

needs to consider economic, social, and environmental impacts in a balanced manner thru the Triple Bottom Line (TBL) framework introduced by Elkington. Until now, the concept is still widely used as a basis for evaluating the sustainability of a project (Loviscek, 2021).

According to Bailey-Johnson et al. (2025), the economy is a part of society, and society is a part of the environment. The existence of society depends on the environment, while economic activities require human capital and natural capital to take place. Thus, Sustainability Project Management is not only oriented toward the successful completion of projects but also toward creating long-term benefits for society, the environment, and the economy in a sustainable manner.

Infrastructure Development and Sustainable Transportation

According to Nurfadhilah et al. (2025), the theory of economic development explains that economic growth and the improvement of community welfare can be achieved thru infrastructure development. Adequate infrastructure plays a role in increasing the efficiency of the production and distribution processes of goods and services, thereby driving economic growth.

Transportation infrastructure is an important element in economic development because it contributes to the improvement of community welfare, economic growth, as well as social and environmental development. Additionally, the development of transportation infrastructure involves various stakeholders, requiring integrated planning and management. (Wang et al., 2018). The development of sustainable transportation infrastructure thru a multimodal transportation system can enhance cost efficiency, service reliability, safety, punctuality, and strengthen trade activities and supply chains. The integration of various modes of transportation also expands regional access and promotes sustainable economic growth (Badassa et al., 2020).

According to Yusuf (2022), the construction of the Jakarta–Bandung High-Speed Train (Whoosh) provides various benefits, including increasing the efficiency of the transportation system, reducing congestion, emissions, and fuel consumption, as well as speeding up travel time. In addition, this project also contributes to job creation, regional economic development, increased business opportunities for SMEs, and increased state revenue. Based on these various benefits, the development of modern transportation infrastructure is expected to create sustainable economic, social, and environmental benefits. One of its implementations in Indonesia is the Jakarta-Bandung High-Speed Rail (Whoosh) project, which serves as an example of modern transportation infrastructure development oriented toward sustainability.

Sustainable Infrastructure and SDGs

Sustainable infrastructure is defined as infrastructure developed thru a process of planning, construction, and maintenance by integrating social, economic, and environmental dimensions. The concept of Sustainable Infrastructure Development (SID) focuses on developing various methods and solutions to realize resilient, sustainable infrastructure that can provide long-term benefits to society and the environment. (Song & Wu, 2021)

To determine the extent to which an infrastructure meets sustainability principles, comprehensive assessment indicators are required. The assessment of the sustainability of transportation systems is generally based on three main dimensions: system effectiveness, efficiency level, and environmental impact. In addition, transportation evaluation also considers the extent to which the system can achieve sustainability goals while providing economic value (Yang et al., 2020).

Sustainable infrastructure has become one of the main instruments in supporting the achievement of the Sustainable Development Goals (SDGs), particularly in the aspects of infrastructure development, sustainable cities, climate action, and economic growth. In the context of Indonesia, the construction of the Jakarta–Bandung High-Speed Rail (Whoosh) not only aims to improve connectivity but also supports more sustainable development. In line with this, Rosojati et al. (2023) explain that the

construction of high-speed train tracks and stations is a strategic step in supporting the realization of sustainable cities and achieving SDG targets thru sustainable infrastructure development.

Artificial Intelligence in High-Speed Rail

Artificial Intelligence (AI) is increasingly being applied to High-Speed Rail systems as one of the main technologies in the management of modern railroad infrastructure (Mutlu & Kaewunruen, 2026). One of the main implementations of AI in the railroad sector is Predictive Maintenance (PdM), which is a data-driven maintenance approach that utilizes real-time and historical asset condition information to predict potential failures before they occur. PdM integrates sensor data, operational records, and machine learning algorithms to support more efficient maintenance planning, reduce downtime, enhance asset reliability, and extend infrastructure lifespan. In addition, the implementation of AI is also supported by the integration of Building Information Modeling (BIM) and Digital Twin, which enables continuous monitoring of asset conditions and supports data-driven decision-making (Mutlu & Kaewunruen, 2026).

Additionally, Li et al. (2024) explain that AI is also realized thru the development of smart platforms that support train operations and maintenance more efficiently, optimize traffic control, and enhance passenger service quality by providing travel information and digital ticketing services. The utilization of this technology contributes to improved operational efficiency, service reliability, and supports the sustainability of the railroad transportation system.

Thus, Artificial Intelligence has great potential in supporting the sustainability of High-Speed Rail systems thru asset maintenance optimization, operational efficiency improvement, safety enhancement, and more effective resource management. Therefore, AI becomes one of the relevant technologies in strengthening the implementation of Sustainable Project Management in modern transportation infrastructure projects.

Method

Research Design

This research uses a Narrative Literature Review approach to examine various literatures on the application of Artificial Intelligence (AI) in supporting Sustainable Project Management in High-Speed Rail (HSR) infrastructure, using the Whoosh Indonesia project as a contextual case study. This approach was chosen to obtain a comprehensive understanding of the development of research, AI implementation, and its potential in enhancing the sustainability of transportation infrastructure projects.

Data Collection

Data was collected thru a literature review of scientific articles, conference proceedings, government reports, company reports, and relevant official publications. The search was conducted using a combination of keywords such as Artificial Intelligence, High-Speed Rail, Sustainable Project Management, Sustainable Transportation Infrastructure, Predictive Maintenance, Digital Twin, and Whoosh Indonesia. Literature was selected based on topic relevance, source quality, and its relation to the research objectives.

Data Sources

The research data sources are obtained from scientific articles originating from international and national databases. The utilization of both types of databases aims to acquire comprehensive literature, both from international research and research developing in Indonesia regarding the application of Artificial Intelligence, High-Speed Rail, Sustainable Project Management, and sustainable transportation infrastructure.

Data Analysis

Data analysis was conducted using thematic analysis. Each selected article was analyzed to identify the research characteristics, research objectives, methods used, applied Artificial Intelligence technologies, and key findings related to the sustainability of the High-Speed Rail system.

Next, the analysis results are grouped into several main themes, namely predictive maintenance, digital twin, intelligent traffic management, and smart operational platform. This grouping is used to compile a literature synthesis to identify the potential contributions of Artificial Intelligence in strengthening Sustainable Project Management in the Whoosh Indonesia project.

Result

The application of AI in the High-Speed Rail (HSR) system has evolved not only in the aspect of predictive maintenance but also in the overall management of train operations. One of its main implementations is the development of a smart platform that supports train operation and maintenance, traffic control, passenger travel information delivery, and digital-based ticketing services (Li et al., 2024). This condition indicates that AI plays a crucial role in enhancing the efficiency, reliability, and quality of services in the High-Speed Rail system.

The study results show that research on the integration of Digital Twin (DT), Building Information Modeling (BIM), and Machine Learning (ML) in railroad maintenance has significantly increased since 2023. Further analysis shows that the integration of data-driven predictive models with digital representations of railroad assets has become the main focus in modern railroad maintenance research. In its implementation, Supervised Learning algorithms are still the most widely used method for detecting railroad infrastructure damage. On the other hand, Reinforcement Learning is beginning to develop as an effective approach in supporting more optimal maintenance scheduling. Moreover, the integration of Building Information Modeling (BIM) with AI can transform previously static three-dimensional models into dynamic media thru continuous sensor data updates. (Mutlu & Kaewunruen, 2026).

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Discussion

The application of Artificial Intelligence (AI) in the High-Speed Rail (HSR) system has evolved from merely a maintenance support technology to a key component in the comprehensive management of railroad operations. The development of smart platforms enables the integration of various operational functions, such as train operation and maintenance, traffic control, passenger travel information delivery, and digital ticketing services.

Additionally, the utilization of Digital Twin supports smarter decision-making processes thru real-time asset condition monitoring, while the application of deep reinforcement learning and imitation learning can enhance the performance of high-speed train control systems. AI is also utilized in integrated monitoring platforms and early warning systems, contributing to the improvement of high-speed train operational safety and reliability (Li et al., 2024).

These developments indicate that AI in the HSR system is no longer limited to automating certain processes, but has become a strategic technology capable of integrating various operational functions into a single system. In the context of the Whoosh Indonesia project, the findings indicate that the application of AI has the potential to enhance the management of high-speed rail infrastructure in a more sustainable manner.

The development of research on the integration of Digital Twin (DT), Building Information Modeling (BIM), and Machine Learning (ML) reflects a paradigm shift in railroad maintenance management. If previously maintenance was more oriented toward corrective or preventive actions, now research is beginning to shift toward data-driven, predictive, and integrated maintenance systems. These changes indicate that digital transformation has become a crucial factor in enhancing the efficiency, reliability, and sustainability of High-Speed Rail systems (Mutlu & Kaewunruen, 2026).

The findings show that digital transformation has become an important factor in improving operational efficiency, asset reliability, and the sustainability of High-Speed Rail systems. The application of AI no longer serves merely to detect faults but also supports more proactive maintenance strategies thru asset condition prediction and operational process optimization. For the Whoosh project, this approach has the potential to extend the service life of the infrastructure, minimize downtime, and improve maintenance cost efficiency, thereby supporting long-term operational sustainability.

Further analysis shows that the integration of data-driven predictive models with digital representations of railroad assets has become the main focus in modern railroad maintenance research. This indicates that the application of AI is no longer only used for detecting damage, but also for supporting a more intelligent and integrated maintenance system (Mutlu & Kaewunruen, 2026). The findings indicate a shift in the maintenance paradigm from a conventional approach to data-driven maintenance, making AI a strategic technology in enhancing operational efficiency and supporting the sustainability of the High-Speed Rail system.

The study results show that the development of high-speed trains not only contributes to the improvement of transportation efficiency but also supports sustainable development thru the strengthening of regional connectivity. The integration of high-speed rail infrastructure with other transportation systems can enhance intercity accessibility, thereby creating opportunities for the formation of new economic corridors. This increased connectivity encourages more effective resource allocation, industrial sector development, and regional economic growth, especially in areas traversed by the high-speed rail line (Rosojati et al., 2023).

In the context of Whoosh Indonesia, the potential of AI to enhance operational efficiency, safety, and service reliability can strengthen the project's contribution to sustainable development goals. Thus, Artificial Intelligence not only serves as an operational technology but also as an enabler that supports the implementation of Sustainable Project Management
in the High-Speed Rail project in Indonesia.

Conclusion

This study explored the potential role of Artificial Intelligence (AI) in strengthening Sustainable Project Management (SPM) within High-Speed Rail (HSR) infrastructure by using the Whoosh Indonesia project as a contextual case study. The findings indicate that AI has evolved beyond predictive maintenance into a strategic technology capable of integrating various operational functions, including digital twin technology, intelligent traffic management, smart operational platforms, and data-driven decision-making. These technologies contribute to improved operational efficiency, asset reliability, safety, and long-term sustainability.

From the perspective of Sustainable Project Management, AI has considerable potential to support the economic, social, and environmental dimensions of sustainability by optimizing resource utilization, reducing operational risks, and improving infrastructure resilience. Although AI implementation in the Whoosh Indonesia project is still developing, the reviewed literature suggests that these technologies could strengthen the long-term sustainability and operational performance of Indonesia's first High-Speed Rail system.

This study contributes to the growing body of knowledge by linking Artificial Intelligence with Sustainable Project Management in the context of High-Speed Rail infrastructure. Future research is

encouraged to examine the practical implementation of AI technologies in the Whoosh project through empirical studies involving operational data and stakeholder perspectives.

Recommendations

Based on the findings, future studies should investigate the actual implementation of Artificial Intelligence technologies in the Whoosh Indonesia project using case study, survey, or interview approaches. Further research may also evaluate the economic, environmental, and social impacts of AI adoption on High-Speed Rail operations to provide stronger empirical evidence for Sustainable Project Management practices. In addition, collaboration among government agencies, railway operators, technology providers, and researchers is recommended to support the gradual adoption of AI-based solutions that enhance operational efficiency, safety, and long-term sustainability.

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References

Agustiranti, T., Kurdiana, A. K. I., Al Ghiffari, B., Juniar, E. D., & Purnama, D. G. (2024). Penerapan Naive Bayes terhadap sentimen analisis media sosial Twitter pengguna Kereta Cepat Jakarta-Bandung (Whoosh). Jurnal Ilmu Komputer dan Sistem Informasi (JIKOMSI), 7(1), 297–305.

Badassa, B. B., Sun, B., & Qiao, L. (2020). Sustainable Transport Infrastructure and Economic Returns: A Bibliometric and Visualization Analysis. *Sustainability*, *12*(5), 2033. https://doi.org/10.3390/su12052033

Bailey-Johnson, Erika, Allyson Green, dan Monica McDaniel. 2025. "Wellness Model for Sustainability." Sustainability and Climate Change 18(1): 22–35. https://doi.org/10.1089/scc.2024.0137

Ersöz, O. Ö., İnal, A. F., Aktepe, A., Türker, A. K., & Ersöz, S. (2022). *A systematic literature review of the predictive maintenance from transportation systems aspect*. *Sustainability*, *14*(21), 14536.

Li, X., Zhu, M., Zhang, B., Wang, X., Liu, Z., & Han, L. (2024). *A review of artificial intelligence applications in high-speed railway systems*. *High-Speed Railway*, *2*(1), 11–16. https://doi.org/10.1016/j.hspr.2024.01.002

Loviscek, V. (2021). Triple bottom line toward a holistic framework for sustainability: A systematic review. Revista de Administração Contemporânea, 25(3), e200017. https://doi.org/10.1590/1982-7849rac2021200017.en

Michaelides, R., Bryde, D., & Ohaeri, U. (2014). Sustainability from a project management perspective: are oil and gas supply chains ready to embed sustainability in their projects? Paper presented at Project Management Institute Research and Education Conference, Phoenix, AZ. Newtown Square, PA: Project Management Institute.

Mutlu, U., & Kaewunruen, S. (2026). *Digitalised predictive maintenance in railways: A systematic review of AI, BIM, and digital twins*. *Infrastructures*, *11*(3), 87. https://doi.org/10.3390/infrastructures11030087

Nurfadhilah, A., Ermawati, A. M. P., Maulidina, D., Lestari, E. P. A., Pratama, M. Z., & Putri, S. O. (2025). Indonesia-China cooperation in Whoosh infrastructure development to improve Indonesia's economy. International Journal of Computer in Law & Political Science, 5(1), 11–16.

PT Kereta Cepat Indonesia China. (n.d.). Profil perusahaan. KCIC. Diakses 22 Juni 2026, dari KCIC Profil

Rosojati, H., Darmastuti, S., & Atiandina, D. (2023). Menatap sustainable development pada kereta cepat. JSEH (Jurnal Sosial Ekonomi dan Humaniora), 9(1), 19–29. https://doi.org/10.29303/jseh.v9i1.201

Soares, I., Fernandes, G., & Santos, J. M. R. C. A. (2024). Sustainability in Project Management Practices. *Sustainability*, *16*(10), 4275. https://doi.org/10.3390/su16104275

Song, Y., & Wu, P. (2021). *Earth observation for sustainable infrastructure: A review*. *Remote Sensing, 13*(8), 1528. https://doi.org/10.3390/rs13081528

Yang, L., van Dam, K. H., & Zhang, L. (2020). Developing Goals and Indicators for the Design of Sustainable and Integrated Transport Infrastructure and Urban Spaces. *Sustainability*, *12*(22), 9677. https://doi.org/10.3390/su12229677

Yusuf, M. F. (2022). Kereta Cepat Jakarta Bandung, Upaya Meningkatkan Kinerja Transportasi Massal di Indonesia. Setkab.Go.Id. https://setkab.go.id/kereta-cepat-jakartabandung-upaya-meningkatkan-kinerjatransportasi-massal-di-indonesia/

Wang, L., Xue, X., Zhao, Z., & Wang, Z. (2018). *The impacts of transportation infrastructure on sustainable development: Emerging trends and challenges*. *International Journal of Environmental Research and Public Health, 15*(6), 1172. https://doi.org/10.3390/ijerph15061172