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From Project to Operations: Human Resource Strategies as Key Success Factors for Jakarta-Bandung High-Speed Railway

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ABSTRACT

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The development of Indonesia's first high-speed railway between Jakarta and Bandung marks a major transition from infrastructure delivery to full operational readiness, requiring not only physical assets but also competent human resources and an effective technology transfer process. This study examines human resource strategies for the Jakarta–Bandung High-Speed Railway, with a focus on workforce requirement planning, workforce fulfillment, and the localisation of operation and maintenance functions. A qualitative descriptive case study approach was employed, drawing on semi-structured interviews, field observations, and document analysis involving PT Kereta Cepat Indonesia China (PT KCIC), Chinese railway experts, the national railway regulator, and Indonesian railway training institutions. The findings indicate that workforce preparation is implemented through three interrelated strategies. First, a structured workforce requirement planning process integrates service plans, demand forecasting, and asset-based workload analysis, resulting in a projected requirement of 1,483 personnel to support 68 daily train services. Second, workforce fulfillment is conducted in phases through recruitment and secondment schemes, with 513 personnel prepared by mid-2023, leaving 970 positions to be filled. Third, localisation and technology transfer are guided by a roadmap implemented through consortium-based arrangements, staged training programs, and the gradual replacement of 812 Chinese experts in critical operational roles. The study underscores the importance of coherent human resource planning and regulation-aligned localisation strategies in ensuring safe, efficient, and sustainable high-speed rail operations in Indonesia.

Keywords: Consortium, Human Resources, Jakarta Bandung High-Speed Railway, Technology Transfer, Workforce Localisation

1. Introduction

The development of efficient transportation systems is crucial for national economic growth, connectivity, and urban mobility. Among various transportation modes, railways offer advantages such as high capacity, speed, energy efficiency, and environmental sustainability (Kadarisman, 2017). As urbanization intensifies, the demand for modern, high-speed railway infrastructure becomes increasingly urgent (Ricardianto et al., 2020). Indonesia's Jakarta–Bandung High-Speed Rail (JBHSR) is the country's first venture into high-speed rail, aiming to reduce travel time between the two economic hubs from three hours to 45 minutes over a 142 km corridor. This project is expected to enhance regional integration, boost productivity, and promote transit-oriented development.

Globally, high-speed rail (HSR) has been a transformative solution for improving transport efficiency. Several countries, particularly in Asia and Europe, have successfully implemented HSR networks with significant economic and technological advancements. Table 1 presents a comparison of HSR systems in selected countries, highlighting differences in network scale, operational speed, and pricing strategies.

Table 1. Comparison of High-Speed Rail Systems

Country	Year of Operation	Network Length (km)	Max Speed (km/h)	Ticket Price (Yuan/km)
Japan	1964	2,041	300	1.71
France	1981	2,142	320	1.02
Germany	1985	1,475	300	1.21
Spain	1992	2,871	300	1.25
China	2008	21,719	350	0.32

Source: Gui et al. (2025)

The JBHSR project was initiated in 2015 after feasibility studies and competitive proposals from Japan and China. Ultimately, China was selected as Indonesia's primary partner due to its cost efficiency, shorter project completion timeline, and financing flexibility (Salim & Negara, 2016). However, while China leads in HSR technology, the transfer of knowledge and operational expertise to Indonesian personnel remains a major challenge (Riyanta & Jannah, 2023).

Despite its strategic importance, the Jakarta–Bandung High-Speed Rail (JBHSR) project continues to face major challenges, including land acquisition constraints, regulatory complexity, and disruptions caused by the COVID-19 pandemic (Octorifadli et al., 2021). In response, the Indonesian government has mandated PT Kereta Cepat Indonesia China (KCIC) to manage not only project implementation but also workforce development and operational readiness. A critical issue in this transition phase is ensuring that Indonesian railway personnel acquire the necessary skills, competencies, and technical expertise to independently operate and maintain high-speed rail systems in the long term (Jin & Jin, 2017).

While existing studies on JBHSR have predominantly emphasized economic feasibility, infrastructure planning, and financial performance, relatively little attention has been paid to human resource strategies for operational phases, particularly in workforce training, competency development, and sustainable knowledge transfer (Rusakova & Bylkov, 2018). Therefore, this study aims to analyze human resource strategies in the JBHSR project by focusing on workforce planning, recruitment processes, and technology and knowledge transfer mechanisms, thereby providing empirical insights for policymakers, railway operators, and the broader transportation sector in preparing for Indonesia's high-speed rail future.

2. Literature Review

This section presents the main theories and empirical studies that underpin the human resource strategies for the Jakarta–Bandung High-Speed Railway project.

2.1. Railway and High-Speed Rail Systems

Railway systems are defined as integrated systems consisting of infrastructure, rolling stock, human resources, and regulatory standards that jointly support safe and efficient transport services. High-speed rail is generally characterised by operating speeds above 250 km/h on dedicated tracks or above 200 km/h on upgraded conventional lines and requires stricter technical specifications than conventional rail, including high quality track structures, reliable power supply, and advanced signalling to ensure capacity, safety, and punctuality (Lawrence et al., 2019; Profillidis, 2016). Experience in countries such as Japan and China shows that high-speed rail can move large passenger volumes while acting as a catalyst for regional development and national connectivity (Lawrence et al., 2019; Profillidis, 2016).

2.2. Human Resources in Railway and High-Speed Rail Operations

Human resources are a critical success factor in railway and high-speed rail operations because new technologies must be matched with appropriate workforce planning, competency standards, and continuous training (Hayashi et al., 2020; Syarief et al., 2022). Many railway operators face overstaffing in routine tasks and shortages in specialised positions, which requires systematic workforce mapping, optimisation of organisational structures, and structured training programs to support technology adoption and safe operations (Profillidis, 2016). Best practices from Japan and China emphasise integrated training systems, combining on the job training, self development, and group training, as well as international training schemes

that facilitate technology transfer and localisation of high-speed rail expertise (Hayashi et al., 2020; Jin & Jin, 2017).

2.3. Previous Research

Previous studies on the Jakarta-Bandung high-speed rail and related projects have mainly examined transport policy, geopolitical interests, and macro level implications of the project, including environmental benefits, national development agendas, and international cooperation between Indonesia and China (Kadarisman, 2017; Octorifadli et al., 2021; Ricardianto et al., 2020). Other works highlight the need for skilled human resources and discuss high level concepts for training, workforce needs in high-speed rail projects, and the role of international collaboration in technology transfer (Hayashi et al., 2020; Riyanta & Jannah, 2023; Rusakova & Bylkov, 2018). However, there is still limited empirical analysis on concrete human resource strategies at the operator level, particularly regarding workforce planning, recruitment sources, training and certification schemes, and phased localisation for the Jakarta-Bandung high-speed rail. This study addresses that gap by proposing a research framework that links service demand, workforce planning and recruitment, training and certification, and technology transfer.
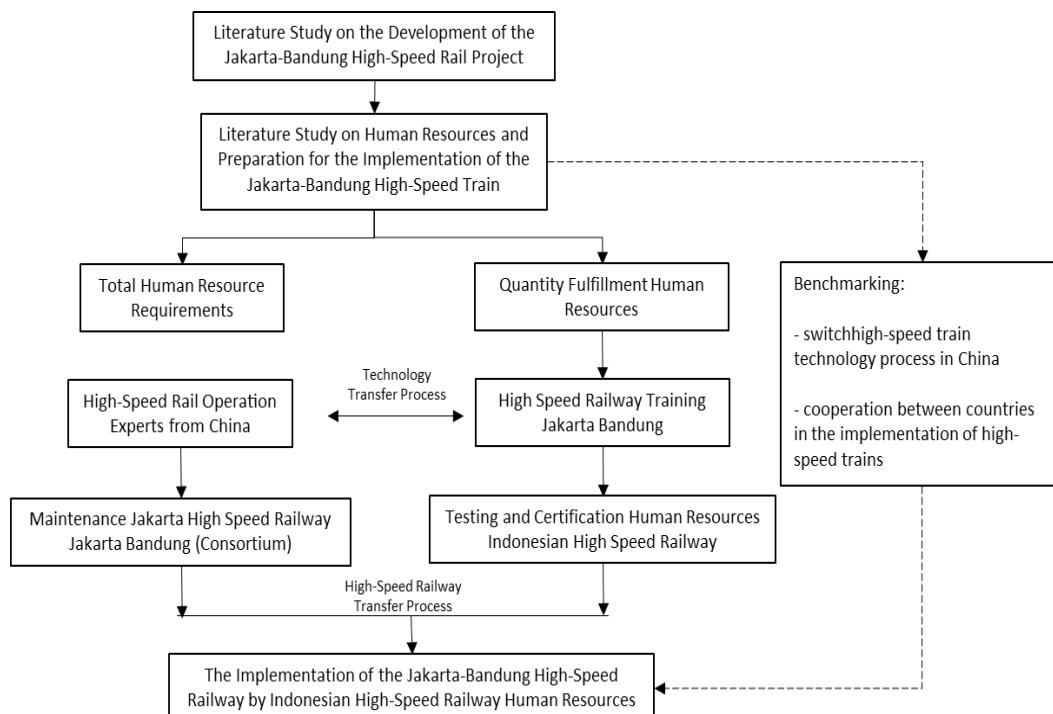

Figure 1. Research Framework for Human Resource Strategies in the Jakarta-Bandung High-Speed Railway Project

3. Methodology

3.1. Research Design

This study uses a qualitative descriptive case study design to explore human resource strategies for the Jakarta–Bandung High-Speed Railway during the transition from project to operations. Qualitative research is appropriate to understand meanings, experiences, and processes from the perspectives of key stakeholders through inductive analysis of rich contextual data (Cresswell, 2008; Sugiyono, 2017). Primary data were collected through observations and in-depth interviews with actors directly involved in high-speed rail operations and regulation, complemented by secondary data from legal documents, organizational policies, and prior studies on high-speed rail. Data collection and analysis were conducted iteratively so that emerging insights could refine subsequent questioning and interpretation (Harahap, 2020).

Purposive sampling was employed because this study does not seek statistical representativeness, but rather analytical depth and relevance. In qualitative case study research, informants are selected based on their direct involvement, expertise, and experiential knowledge of the phenomenon under investigation (Creswell,

2008). The transition from project to operations in a high-speed rail system is a complex and specialized process that can only be adequately explained by actors who participate in workforce planning, regulation, training, and technology transfer. Therefore, purposive sampling enabled the researcher to access information-rich participants capable of providing detailed insights into human resource strategies, institutional arrangements, and operational challenges that would not be observable through random selection. This approach is consistent with qualitative inquiry, where the aim is to develop a contextualized understanding rather than to generalize findings statistically.

3.2. Research Sample

The research employed purposive sampling to select information-rich participants who are directly involved in preparing human resources for Jakarta–Bandung high-speed rail operations. Informants included experts from Beijing Railway Administration and China Railway International, managers from PT Kereta Cepat Indonesia China responsible for human resources and training, officials from the Directorate General of Railways overseeing certification, and representatives from Indonesian railway training institutions. In qualitative research, the number of informants is not aimed at statistical generalisation but at achieving depth and completeness of understanding of the studied phenomenon (Harahap, 2020; Nugrahani, 2014). Secondary data were drawn from Indonesian railway legislation, ministerial regulations, and national railway master plans related to high-speed rail.

3.3. Data Collection Tools and Procedure

Data were collected using semi structured interview guides, observation notes, and document review checklists, with the researcher acting as the main instrument of inquiry (Sugiyono, 2017). A total of 15 in-depth interviews were conducted with key stakeholders, including representatives from PT KCIC, Chinese experts, Indonesian operators, regulators, and training institutions. Each interview lasted approximately 45-90 minutes and was conducted either face-to-face or online, depending on participant availability. The semi-structured interview guide was developed based on the research objectives and relevant literature and is available upon request. Observations were conducted at PT KCIC to understand organisational readiness and workforce planning practices, while in-depth interviews explored perspectives on workforce needs, training design, certification, and technology transfer from Chinese, Indonesian operator, regulator, and training institution stakeholders. Document analysis covered laws, regulations, internal reports, feasibility studies, and training curricula relevant to high-speed rail human resources. Triangulation across interviews, observations, and documents was used to enhance the completeness and credibility of the data (Nugrahani, 2014; Rijali, 2018).

3.4. Data Analysis

Data analysis followed an inductive qualitative approach consisting of data reduction, data display, and conclusion drawing and verification (Sugiyono, 2017). Interview transcripts, observation notes, and documents were first organised and coded into initial categories related to workforce planning, recruitment sources, training and certification, and technology transfer. These categories were then refined into broader themes that link human resource strategies to regulatory requirements and operational targets for high-speed rail. Throughout the process, patterns and relationships among themes were examined to construct a coherent explanation of how PT KCIC plans and implements human resource development for Jakarta–Bandung high-speed rail operations. Credibility was supported through constant comparison, triangulation of sources and methods, and peer discussion of emerging interpretations (Rijali, 2020).

3.5. Ethical

The study complied with ethical principles for qualitative research, including respect for participants, confidentiality, and responsible use of data. All informants were approached through formal channels and provided informed consent after receiving an explanation of the research objectives, voluntary nature of participation, and use of their information for academic purposes only. Personal names are not disclosed in the article and respondents are referred to by institutional roles to protect anonymity. Access to organisational documents and observation sites was obtained with permission from the relevant institutions, and all analyses were conducted in line with the ethical standards of the author's university and applicable regulations for research involving professional practitioners.

4. Results and Discussion

This section presents the empirical findings on workforce requirement planning, workforce fulfillment, and localisation strategies for the Jakarta Bandung high speed rail project. The results are then discussed in relation to human resource planning theory, high speed rail operation and maintenance practices, and international experience in technology transfer.

4.1. Research Results

4.1.1. Workforce requirement planning for Jakarta Bandung high speed railway

The Jakarta Bandung high speed rail is a national strategic project developed through a joint venture between Indonesian state owned enterprises and Chinese railway companies, with PT Kereta Cepat Indonesia China (KCIC) as project owner (Dharma & Suryadinata, 2018). The project uses an engineering, procurement, and construction contract model in which the High Speed Railway Contractor Consortium (HSRCC) must deliver a fully operational system at turn key stage based on the FIDIC EPC/Turnkey Conditions of Contract (Faizah, 2021). By the end of June 2023 construction progress had exceeded 90 percent and the line had entered the testing and commissioning phase using inspection trains operated by PT KCIC, while preparation of operational human resources became an urgent requirement in line with government safety expectations. Workforce requirement planning was carried out together with Beijing Jingtie Foreign Economic and Technical Cooperation Ltd. (JTFEC), drawing on Chinese high speed rail experience and the feasibility study prepared by LAPI ITB and China Railway Design Corporation. The joint process covered demand forecasting, determination of daily train services, asset mapping along the 142.3 kilometre corridor, definition of five functional areas (operations, rolling stock maintenance, infrastructure maintenance, safety, and comprehensive management), and the design of organisational structures and workload. Based on these stages, three scenarios of workforce requirements were produced, as summarised in Table 2.

Table2. Workforce requirements for Jakarta Bandung high speed rail by functional area and scenario

Functional area	Consultant 2020 (100 trains per day)	KCIC review 2022 (68 trains per day)	KCIC review 2023 with revised outsourcing strategy
Corporate management	2	1	1
Operations	448	387	418
Rolling stock maintenance	262	207	207
Infrastructure maintenance	800	789	789
Safety	27	26	26
Comprehensive management	49	42	42
Total	1,588	1,452	1,483

Source: processed from KCIC internal documents.

Table 2 shows that the largest share of personnel is concentrated in infrastructure maintenance, followed by operations, which reflects the asset intensive nature of high speed rail. The total requirement decreased from 1,588 to 1,452 personnel when the planned number of train services was reduced from 100 to 68 per day, and then increased slightly to 1,483 personnel after KCIC decided to internalise some passenger service positions that were previously planned to be outsourced.

4.1.2. Workforce fulfillment and remaining gaps

Based on the final requirement of 1,483 personnel, PT KCIC distinguishes between certified and non certified positions, with certified staff concentrated in safety critical functions in operations, EMU maintenance, fixed asset maintenance, and SSHE. Workforce fulfilment is pursued through multiple channels, including KCIC's own recruitment, secondment from PT Kereta Api Indonesia (Persero) and PT Kereta Commuter Indonesia, and prioritises positions needed for initial commercial operation, especially in passenger services, maintenance, and safety. As of 3 July 2023, a total of 513 personnel had been prepared, while 970 positions remained to be filled (KCIC internal data). Details are presented in Table 3.

Table 3. Fulfilment of workforce requirements for Jakarta Bandung high speed rail (July 2023)

No.	Functional area	Required Human Resources	Fulfilled				Remaining
			KCIC	KAI	KCI	Total	
CERTIFIED							
1	O and M management	–	–	–	–	–	–
2	Operation	170	69	90	–	159	11
3	EMU maintenance	142	22	14	41	77	65
4	Fixed asset maintenance	689	41	69	–	110	579
5	O and M SSHE	9	1	–	–	1	8
6	Comprehensive management	–	–	–	–	–	–
Sub total certified		1.010	133	173	41	347	663
NON CERTIFIED							
1	O and M management	1	1	–	–	1	–
2	Operation	248	52	47	–	99	149
3	EMU maintenance	65	3	5	6	14	51
4	Fixed asset maintenance	100	7	14	–	21	79
5	O and M SSHE	17	6	5	–	11	6
6	Comprehensive management	42	19	1	–	20	22
Sub total non certified		473	88	72	6	166	307
Total		1.483	221	245	47	513	970

4.1.3. Localisation and technology transfer strategy

Because high speed rail is a new technology in Indonesia, PT KCIC and the government decided to adopt an international consortium model for operation and maintenance. A consortium between China Railway and PT Kereta Api Indonesia (Persero) is responsible for providing technical services and supplying 812 experienced Chinese high speed rail personnel during the initial operation period. These personnel occupy critical positions in operations, rolling stock maintenance, infrastructure maintenance, safety, and training. Cooperation agreements between PT KCIC, PT KAI, and Tianyou Jingtie Engineering Consulting Co. Ltd. define the division of responsibilities and set out the objectives of optimising resources and ensuring safe operation under Indonesian law.

In parallel, PT KCIC, the consortium, and the Ministry of Transportation have designed a staged localisation and technology transfer plan. The plan is structured around three main elements. First, structured training programmes for Indonesian personnel are delivered in several waves at PPI Madiun and on site in the Jakarta Bandung corridor. The programmes cover EMU drivers, OCC controllers, on call emergency controllers, passenger service personnel, rolling stock technicians, and infrastructure maintenance staff. Second, on the job training and mentoring are implemented, in which Indonesian personnel who have completed classroom and simulator training work alongside Chinese experts in real operation and maintenance tasks. The localisation process consists of three stages: observation of tasks performed by Chinese personnel, performance of light tasks under supervision, and performance of full tasks under continued oversight. Third, a progressive reduction in foreign experts is combined with incremental increases in certified Indonesian personnel, with the goal of achieving a one to one ratio between Indonesian and Chinese staff in critical positions and eventually full local operation within the time frame permitted by regulation (K. P. R. Indonesia, 2022, 2023a).

The training schedule for EMU drivers illustrates the complexity of localisation in safety critical roles. Training is planned in two waves, with a total duration of approximately 18 months from the start of theoretical training to completion of technology transfer. Localisation of EMU driver positions is expected to be achieved later than most maintenance positions since train driving requires not only technical knowledge of the EMU system but also advanced cognitive and non technical skills related to situational awareness, communication, and emergency response (Lawrence et al., 2019). In contrast, localisation in some infrastructure maintenance fields can proceed more quickly, particularly for personnel who already have experience in conventional railway systems, as long as they master new standards, procedures, and high speed specific equipment.

Overall, the results indicate that workforce preparation for the Jakarta Bandung high speed rail is being pursued through three interrelated strategies: a structured workforce requirement planning process that links demand forecasts, service plans, and asset based workload analysis; phased workforce fulfillment through multiple recruitment channels and staged priority setting; and a localisation and technology transfer roadmap that combines intensive training, on the job mentoring, and regulatory requirements for certification and foreign worker withdrawal.

4.2. Discussion

Workforce planning for the Jakarta–Bandung High-Speed Rail was initially shaped by Chinese operational experience but required substantial adjustment to Indonesian institutional, regulatory, and market conditions. The initial estimate of 1,588 personnel for 100 daily train services reflected a conservative staffing model commonly observed in early-stage high-speed rail operations, where safety and operational reliability are prioritized over efficiency. Subsequent revisions that reduced daily services to 68 trains and modified outsourcing policies lowered staffing requirements to 1,452 and later 1,483 personnel, illustrating how workforce planning in high-speed rail systems is highly sensitive to demand forecasts, service patterns, and corporate strategy. Similar adaptive workforce recalibration has been reported in other high-speed rail systems as operations mature and operational data become available (Hayashi et al., 2020). The concentration of personnel in infrastructure maintenance, followed by operations, aligns with international experience and reflects the asset-intensive nature of high-speed rail, where fixed assets such as track, catenary, signalling, telecommunications, and power supply require continuous inspection and preventive maintenance regardless of train frequency. From a rolling stock perspective, multi-level EMU maintenance cycles significantly influence technician requirements and reinforce the need for advanced, technology-supported maintenance approaches to improve long-term efficiency (Hayashi et al., 2020).

The findings further reveal persistent gaps in certified personnel, particularly in fixed asset and EMU maintenance, underscoring the structural challenge of rapidly developing a domestic pool of high-speed rail specialists. Comparable studies indicate that localisation in high-speed rail systems typically requires long time horizons due to the complexity of safety-critical competencies and certification processes (Hayashi et al., 2020; Komobuchi, 2009). PT KCIC's multi-channel workforce fulfilment strategy, combining secondment from PT Kereta Api Indonesia and PT Kereta Commuter Indonesia, recruitment from railway education institutions, and consortium-based cooperation with China Railway, reflects practices observed in other countries adopting foreign high-speed rail technology (Chen & Haynes, 2016). The staged training and mentoring approach, progressing from classroom learning to supervised operation, aligns with competency-based training models used in Japan and Europe and supports gradual but sustainable localisation (Komobuchi, 2009). However, in the long term, continued reliance on foreign experts may pose cost and dependency risks if certification pipelines and institutional learning mechanisms are not sufficiently strengthened. For Indonesia, these findings have broader implications for future high-speed rail and large-scale infrastructure projects, highlighting the need for integrated human resource policies, long-term training investment, and regulatory frameworks that explicitly link technology transfer obligations with workforce certification and localisation targets (Chen & Vickerman, 2019; Chen & Haynes, 2016).

5. Conclusion

The study demonstrates that effective preparation of human resources for the Jakarta-Bandung High-Speed Railway depends on three interrelated strategies that support the transition from project implementation to full-scale operations. Workforce requirement planning, initially derived from international benchmarks, was progressively recalibrated to reflect Indonesian demand patterns, regulatory constraints, and financing limitations, resulting in a final estimated requirement of 1,483 personnel for 68 daily train services. Workforce fulfillment has been pursued through multiple recruitment channels and a consortium-based model involving China Railway and PT Kereta Api Indonesia, enabling the deployment of an initial cohort of certified and non-certified personnel. Nevertheless, substantial gaps remain in safety-critical operation and maintenance functions, indicating that human resource readiness remains a key operational risk in the early years of service. This study addresses a gap in previous high-speed rail research, which has largely focused on infrastructure, financing, and economic impacts while giving limited attention to human

resource strategies during the transition from project to operations. The findings extend existing literature by demonstrating that workforce planning, fulfillment, and localisation are interdependent processes rather than standalone activities. The study also shows that workforce requirements in high-speed rail are dynamic and must be continuously adjusted to service levels, regulatory constraints, and organisational decisions, challenging the static staffing assumptions found in earlier studies. By highlighting the role of consortium-based training and staged technology transfer in building domestic operational capacity, this research contributes to a more integrated theoretical understanding of human resource development and capability building in large-scale transport infrastructure projects.

From a practical perspective, the findings underscore that Indonesia's high-speed rail development relies not only on the delivery of physical infrastructure and rolling stock, but also on a coherent and integrated human resource strategy that systematically links workforce planning, fulfillment, and localisation within clearly defined regulatory timelines. PT KCIC and relevant government agencies should therefore prioritise the acceleration of training and certification programmes, ensure that staff secondment does not undermine the capacity of conventional rail services, and strengthen long-term investments in national training centres, simulators, and curricula specifically designed for high-speed rail technology. At the policy level, the study highlights the need for sector-wide human resource planning frameworks that align technology transfer obligations, certification systems, and localisation targets across Indonesia's railway industry. Future research is recommended to examine the long-term relationships between workforce structure, safety performance, operational efficiency, and the broader spillover effects of high-speed rail development on Indonesia's national railway ecosystem.

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