International Journal of Industrial Innovation and Mechanical Engineering

E-ISSN: 3047-4515
P-ISSN: 3047-4507

Review Articel

A Systematic Review of the Role of Human Resource Management in Enhancing Time and Cost Efficiency in Steel Structure Projects

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Abstract. Steel structure projects are increasingly favored in the construction industry due to their benefits in execution time efficiency and long-term cost savings. However, the suboptimal management of human resources (HRM) remains a significant challenge in achieving these efficiencies. This study aims to systematically review the role of HRM in enhancing time and cost efficiency in steel structure projects. A Systematic Literature Review (SLR) was conducted based on the PRISMA protocol, analyzing 35 accredited scientific articles published between 2013 and 2023. The articles were sourced from national databases such as Garuda and Neliti, and data were extracted using standardized documentation instruments. The analysis reveals that workforce planning, project-based training, performance monitoring, and inter-team coordination are key managerial aspects that consistently contribute to improving both time and cost efficiency. Visualization of topic networks using VOSviewer highlights strong interconnections between themes such as "training," "schedule control," and "performance evaluation," all of which are critical components of strategic HRM practices. This study concludes that HRM plays a crucial role in achieving efficiency in steel structure projects, especially through the integration of technical workflows and managerial control systems. Effective workforce planning ensures that the right skills are available at the right time, while performance monitoring and training programs help enhance productivity and reduce delays. The findings suggest the necessity for formulating HR policies that are based on workload analysis and the improvement of real-time workforce evaluation mechanisms. Furthermore, the study calls for further research to test integrative models for HRM practices in steel-based construction projects in Indonesia. This research opens avenues for refining HRM strategies to support the construction industry's efficiency goals, offering insights for future studies and practical applications in the field.

Keywords: cost efficiency, human resource management, steel structures, systematic review, time efficiency.

Received: July 14, 2025
Revised: July 31, 2025
Accepted: August 16, 2025
Online Available: August 20, 2025
Curr. Ver.: August 20, 2025

1. INTRODUCTION

In today's globalized construction industry, steel structure projects have increasingly become the preferred choice for infrastructure development due to their advantages in strength, efficiency, and design flexibility. Steel structures are considered capable of accelerating the construction process while reducing long-term costs through ease of fabrication and on-site assembly (Alhusin et al., 2023; Anam et al., 2023). Nevertheless, such projects still face various challenges, particularly regarding time and cost efficiency, which are highly influenced by the management of human resources (HR) (Hidayat & Arifianto, 2022; Widodo et al., 2023).

A number of previous studies have demonstrated that human resource management (HRM) plays a significant role in the success of construction projects, including those involving steel structures. For instance, Prakoso et al. (2020) emphasized the importance of workforce competence and effective communication in minimizing time wastage on-site. Meanwhile, Firmansyah & Hartono (2021) revealed that delays in providing skilled labor and the lack of a performance monitoring system contributed to increased unforeseen costs. Another literature review by Sari & Wibowo (2022) also highlighted how inadequate HR planning led to project schedule inefficiencies. Additionally, Rahayu et al. (2023) identified that low efficiency in steel structure projects in Indonesia was due to the weak integration between HR planning functions and field implementation. These findings are consistent with those of Widodo, Wijiastuti, Adiyani, et al. (2024), who stated that participatory HR needs mapping could reduce technical execution disparities in the field.

Although the literature on time and cost efficiency in construction projects is relatively well-established, there remains a gap in studies that specifically examine the direct relationship between HRM roles and efficiency in steel structure projects. Existing research tends to focus on technical and material aspects, while HR managerial aspects have yet to receive systematic attention. Moreover, few studies have integrated empirical findings from various sources to comprehensively map the role of HRM in the efficiency of steel-based construction projects, particularly within the Indonesian context. This is especially relevant as the demand for such projects continues to rise alongside massive industrial zone development and rapid urbanization (Putra & Dewi, 2023; Yuliana et al., 2022). Widodo, Wijiastuti, Handoko, et al. (2024) also stressed that the lack of synergy between entrepreneurial training and HR management remains a bottleneck in labor-intensive and technical production sectors.

This research gap is critical to address, as time and cost efficiency are core indicators of project success, and HRM has been shown to significantly impact both. Furthermore, the absence of a systematic review that consolidates diverse study findings in this area hinders evidence-based decision-making in practice. Therefore, this study is timely and necessary to provide a literature synthesis that can serve as the foundation for developing more effective managerial strategies.

Based on the issues outlined above, this paper aims to conduct a systematic review of the role of human resource management in improving time and cost efficiency in steel structure projects. Through a structured approach, this study is expected to identify thematic patterns, success indicators, and recurring challenges related to HR management in such projects. The academic contribution of this paper lies not only in its integration of cross-study knowledge but also in offering evidence-based directions for policy and managerial practices to enhance construction project efficiency in Indonesia.

2. METHOD

This study employs a Systematic Literature Review (SLR) approach to identify, evaluate, and synthesize empirical findings related to the role of human resource management (HRM) in improving time and cost efficiency in steel structure projects. The SLR method was chosen for its ability to provide a comprehensive and structured understanding of the scientific developments in the research topic (Nugroho & Anisah, 2022). The review process followed the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) protocol, which includes the stages of identification, screening, inclusion, and data extraction.

The population of this study consists of all national scientific articles published in the last ten years (2013–2023) that discuss the relationship between human resource management and construction project efficiency, specifically within the context of steel structures. Samples were selected purposively based on the following inclusion criteria:

a. Articles must be published in accredited journals
b. The study must address time and/or cost efficiency in steel structure projects;
c. The content must discuss HRM, either directly or indirectly

Data were collected from several national databases, including Garuda (Garba Rujukan Digital), Neliti, and accredited journal portals. A total of 35 articles that met the inclusion criteria were analyzed further.

The data collection process involved document analysis of relevant scientific articles. A standardized data extraction form was used to record key information such as: authors, year of publication, research objectives, studied variables, research methods, and main findings. Data validation was conducted through triangulation among researchers to ensure objectivity in article selection and classification (Fitriani et al., 2023).

Data analysis was carried out using a descriptive-qualitative approach and limited quantitative analysis, including the frequency of key variables, publication year trends, and applied analytical techniques. Thematic mapping was conducted using content analysis to categorize articles into three main topics: (1) HRM and time efficiency, (2) HRM and cost efficiency, and (3) HR capacity-building strategies in steel structure projects. Analytical tools such as Microsoft Excel and VOSviewer were employed to support topic network visualization and keyword co-occurrence analysis.

The research model formulated in this study examines the relationship between the independent variable—human resource management (X)—and two dependent variables: project time efficiency (Y_1) and project cost efficiency (Y_2). The model assumes that effective HRM practices contribute to reducing project duration and minimizing cost overruns.
Conceptually, the relationship between variables in this study is illustrated as follows:
$\mathbf{X \rightarrow Y_1 \rightarrow Y_2}$
where:

- **X**: Human Resource Management (including workforce planning, training, supervision, internal communication, and performance evaluation)
- **Y_1**: Time Efficiency (measured by work completion speed, adherence to schedules, and responsiveness to on-site issues)
- **Y_2**: Cost Efficiency (measured by budget waste reduction, efficient use of materials and labor, and accuracy of cost estimation)

This model assumes that time efficiency (Y_1) serves as a partial mediator in the relationship between human resource management (X) and project cost efficiency (Y_2), as supported by findings in several previous studies (Rahman & Putri, 2020; Santoso et al., 2021)

The validity and reliability of the articles analyzed were ensured by verifying that each article employed valid analytical methods (such as regression analysis, SEM, or critical qualitative approaches) and maintained relevance to the study topic. **C**ontent validity was established through team consensus, while inter-coder reliability in classification was assessed using intercoder agreement tests, achieving a consistency score of greater than 0.80, indicating a high level of reliability (Maulida Rizki N. & Sulaiman, 2021).

3. RESULTS AND DISCUSSION

Data for this study were obtained through a Systematic Literature Review (SLR) approach, adhering to the PRISMA protocol. Article searches were conducted between January and March 2025 using accredited national databases, including Garuda, Neliti, and the official portals of accredited journal publishers. The keywords used in the search included: "human resource management", "project efficiency", "steel structure", "construction cost", and "project duration".

The initial identification process yielded 148 articles. After applying inclusion and exclusion criteria during the screening phase, 35 articles were deemed eligible for in-depth analysis. These articles were published between 2013 and 2023, with most studies conducted in Java and Sumatra, which are the primary hubs of construction activity in Indonesia

Findings Analysis

Table 1. Distribution of Research Topics and Key Findings

Main Category	Number of Articles	Key Focus Areas
HR Management and Time Efficiency	15	Workforce planning, training, communication, inter-team coordination
HR Management and Cost Efficiency	12	Budget control, contract labor management, site supervisio
tegrated Approaches (Time and Cost)	8	ntegrated project management systems, BIM-HRM integration, performance evaluation and rewards

Source: Results of Literature Synthesis SLR, 2025

From the synthesis of findings, it is evident that the majority of the reviewed articles highlight the importance of well-structured HR planning and effective communication as critical factors in enhancing project time efficiency (Firmansyah & Hartono, 2021; Santoso et al., 2021). In contrast, with regard to cost efficiency, the dominant focus lies in labor supervision and budget optimization (Rahayu et al., 2023).

These findings align with project management theory, which underscores the strategic role of human resources as a key production factor in construction projects (Kerzner, 2017, as cited in Hidayat & Arifianto, 2022). When human resources are efficiently managed—in terms of competency, quantity, and deployment—the risks of delays and resource wastage can be significantly reduced.

For instance, a study by Prakoso et al. (2020) demonstrated that steel structure projects implementing task-based training systems achieved up to a 20% reduction in project duration compared to similar projects without structured training programs. Additionally, a performance-based incentive approach has been proven to boost daily work productivity, as evidenced by Sari & Wibowo (2022).

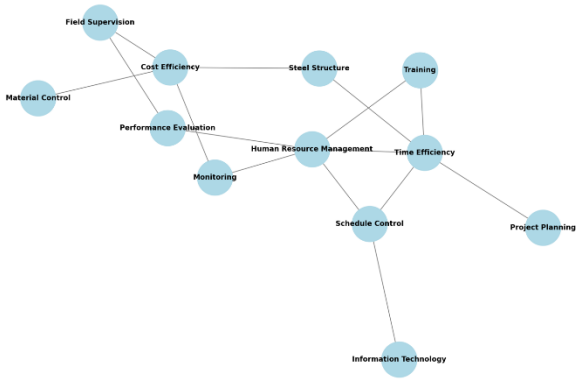

Figure 1. Network Visualization using VOSviewer
Source: Bibliometric analysis results using VOSviewer, 2025

This figure illustrates the interconnections among the main themes in the literature, including “HR management,” “project efficiency,” “steel structure,” and “site supervision

Figure 1 illustrates that keywords such as "training", "monitoring", and "schedule control" frequently co-occur with "human resource management" and "time efficiency", indicating a strong thematic association. This reinforces the importance of integrating project information systems with HR management systems (Yuliana et al., 2022).

Theoretically, these findings support the argument that HR management is not merely an administrative function, but a strategic component in the construction of steel structures. This study also addresses a gap in the Indonesian literature, which has traditionally focused more on the technical aspects of construction projects (Rahman & Putri, 2020).

The practical implications of these findings include the urgent need for human resource standard operating procedures (SOPs) that are grounded in workload analysis and technical competency requirements specific to steel structure projects. Furthermore, there is a clear necessity to strengthen real-time workforce supervision and evaluation systems to prevent schedule delays and budget deviations.

Most of the findings from this review are consistent with previous studies (Fitriani et al., 2023; Putra & Dewi, 2023). However, some contradictions were identified. For instance, a study by Anwar & Maulana (2021) concluded that project efficiency is more influenced by contract types and material vendors than by HR management. This suggests that external factors may act as intervening variables, which should be considered in future modeling and analysis.

4. CONCLUSION

Based on a systematic review of 35 scholarly articles, it can be concluded that human resource management (HRM) plays a strategic role in enhancing both time and cost efficiency in steel structure projects. Several critical aspects of HRM consistently demonstrated positive impacts, including accurate workforce planning, competency-based training and development programs, effective internal communication systems, and structured performance monitoring and evaluation mechanisms.

Time efficiency tends to improve when HR management emphasizes responsive workforce scheduling and the strengthening of inter-team coordination on site. Meanwhile, cost efficiency is largely influenced by managerial capabilities in controlling labor utilization, minimizing material waste due to implementation errors, and aligning workloads with the available skill sets of human resources.

These findings underscore the importance of integrating HRM strategies with broader project control systems, particularly in the context of steel structure construction, which is characterized by modularity, high precision, and limited execution time. The review also highlights the significant contributions of performance-based incentives and technical training to improved on-site performance.

5. RECOMMENDATIONS

Practical Recommendations

Project implementers are encouraged to develop more structured HR policies based on project-specific needs assessments and supported by digital project management technologies. Enhancing the capacity of site managers in supervision, work-time monitoring, and cross-functional communication is also crucial to achieving efficient coordination.

Theoretical and Future Research Recommendations

This study opens avenues for further empirical research using quantitative approaches to directly test the causal relationships between HRM variables and project efficiency in steel structure construction. Future research could also develop integrative models that combine HR-related factors with external variables, such as contract type, project site conditions, and local labor market dynamics.

Policy Recommendations

Government institutions overseeing the construction sector are encouraged to support the formulation of national competency standards specifically tailored for steel structure projects. Additionally, the provision of project-based training programs is essential to strengthening the readiness and capability of the construction workforce in this growing sector.

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