

ISSN 1840-4855

e-ISSN 2233-0046

Original scientific article

<http://dx.doi.org/10.70102/afts.2026.1836.422>

THE MEDIATING ROLE OF OCCUPATIONAL SAFETY MANAGEMENT SYSTEMS IN THE RELATIONSHIP BETWEEN ERGONOMIC DESIGN AND WORKPLACE ACCIDENTS: EVIDENCE FROM THE CONSTRUCTION INDUSTRY

I. Ketut Sutapa^{1*}, I. Gede Fery Surya Tapa², I. Wayan Sujahtra³, Putu Hermawati⁴,
I. Ketut Parti⁵, I. Wayan Intara⁶

^{1*}Lecturer, Department of Civil Engineering, Politeknik Negeri Bali, Badung, Bali, Indonesia. e-mail: ketutsutapa@pnb.ac.id, orcid: <https://orcid.org/0000-0002-3513-993X>

²Lecturer, Civil Engineering Study Program, Faculty of Engineering and Informatics, Universitas Pendidikan Nasional, Denpasar, Bali, Indonesia.

e-mail: ferysuryatapa@undiknas.ac.id, orcid: <https://orcid.org/0000-0003-2017-2646>

³Lecturer, Department of Civil Engineering, Politeknik Negeri Bali, Badung, Bali, Indonesia. e-mail: wayansujahtra@pnb.ac.id,
orcid: <https://orcid.org/0009-0004-1785-9820>

⁴Lecturer, Department of Civil Engineering, Politeknik Negeri Bali, Badung, Bali, Indonesia. e-mail: hermawati@pnb.ac.id, orcid: <https://orcid.org/0009-0003-9240-3412>

⁵Lecturer, Department of Electrical Engineering, Politeknik Negeri Bali, Badung, Bali, Indonesia. e-mail: partigen@pnb.ac.id, orcid: <https://orcid.org/0009-0003-3691-7179>

⁶Lecturer, Department of Civil Engineering, Politeknik Negeri Bali, Badung, Bali, Indonesia. e-mail: bobintara@gmail.com, orcid: <https://orcid.org/0009-0006-4023-6669>

Received: May 16, 2026; Revised: June 25, 2026; Accepted: August 05, 2026; Published: September 29, 2026

SUMMARY

It is well-known that the construction industry ranks among those industries in which there are many cases of injury and workplace accidents for workers despite the advances in the development of various safety regulations and management practices. This paper aims at examining the role of OHSMS in mediating the relationship between ergonomic design and workplace accidents in construction works in Bali, Indonesia. The following research is conducted through employing a quantitative methodology, where a survey among 100 construction workers is conducted as an intentional sample. The instruments employed for gathering empirical evidence were validated Likert scale questionnaires, which measure ergonomic design, effectiveness of OHSMS, and workplace accidents. The obtained data was tested using the SEM approach through utilizing AMOS 26 software, while the effects were estimated using bootstrap technique with 5,000 replications. It was found out that ergonomic design had a significant positive influence on OHSMS ($\beta=0.45$, $p<0.001$) and reduced the likelihood of workplace accidents ($\beta=-0.35$, $p<0.001$). Moreover, it was determined that the use of OHSMS greatly lowered the number of accidents in workplaces ($\beta=-0.40$, $p<0.001$). As for the mediation effect, it was established that there was a strong relation between the employment of OHSMS and reducing workplace accidents ($\beta=-0.18$, $p<0.001$). Ergonomic designs are therefore more successful as accident reduction strategies when used together with formal OHSMS. The model has the ability to explain 45% of the variance in OHSMS and 53% of the variance in workplace accidents, which means it has considerable explanatory

power. From the findings of the study, it can be said that ergonomics, together with OHSMS, can help reduce construction accidents. This research makes contributions to Human Factors Theory and Systems Theory.

Key words: *ergonomic design, occupational health and safety management system, workplace accidents, construction safety, structural equation modeling, human factors, safety management systems.*

INTRODUCTION

The construction industry is one of the most dangerous in the world and has the highest risk of occupational injury, accident, and death, even though there has been an evolution in safety policies and systems in the workplace. Safety performance in construction activity generally faces multiple physically demanding activities, a variable and unpredictable environment, risky equipment, and repetitive activities, and involves several interactions among workers, equipment, organizational processes, and the environment, which greatly lead to an increase in occupational risk [2][13]. The risk is considerably higher in developing countries, where implementation of safety policies is less systematic, resources are limited, and safety culture awareness is low, causing loss of money, decrease in work productivity, and long-term worker injury and disability [3][20]. In Indonesia, in spite of the implementation of the Occupational Health and Safety Management System (OHSMS/SMK3), workplace accidents at construction sites are still an issue, with common causes such as noncompliance with safety procedures, ergonomic design failures, lack of supervision, and weak integration of safety culture [4][15][17].

The concept of ergonomics is widely applied at work to reduce workplace risks and improve safety and productivity. It is an approach to designing the systems, processes, jobs, tools, and the work environment for human safety and to match human ability. The poor working environment that can lead to musculoskeletal disorder, fatigue, poor postures, risk of injury among workers, and increase accident are Ergonomic work system design, job design, tool design, and physical work space design, where the quality of the environment, job and tool quality contribute to an increased accident rate [8][18][16]. A good Ergonomic workplace and tools are found to be able to reduce workplace safety incidents and to increase workers' safety behavior [5][20]. On an organizational level, OHSMS has an important function of establishing hazard identification systems, training, supervision, communication, and control mechanisms for risks, leading to improvements in OHS compliance and the development of the organization's safety culture [9][7]. However, studies have identified that OHSMS alone is not sufficient for safety if Ergonomic and human aspects are not included in the OHS strategy [19].

Several studies have explored the effects of Ergonomics and safety management in the workplace separately; however, the combined effect of ergonomics and safety management on the incidence of workplace accidents, especially in the mediating role of OHSMS in the relationship between ergonomics design and workplace accidents, has still attracted limited research, especially in developing countries like Indonesia [1]. The proposed theory of this study is that ergonomic improvement not only directly affects the decrease in workplace accidents, but it can also indirectly improve safety through strengthening the OHSMS, safety participation, and organizational safety culture.

Research Objectives

The purpose of this study is to investigate the influence of OHSMS on the relationship between ergonomic design and workplace accidents in the construction industry. In particular, this study has four main aims:

- 1) To examine the impact of ergonomic design on the effectiveness of OHSMS,
- 2) To analyze the direct impact of ergonomic design on workplace accidents,
- 3) To test the effect of OHSMS on workplace accidents and
- 4) To investigate whether the OHSMS mediating effect exists on the impact of ergonomic design on workplace accidents.

Research Questions

In order to answer this, the study uses the research questions listed below:

- How does ergonomic design affect the efficiency of OHSMS?
- What is the effect of ergonomic design on accidents on the construction site?
- How does OHSMS affect the reduction of accidents on the site?
- Does OHSMS have a mediating effect on ergonomic design and accidents on the construction site?

This paper will continue in the following sections. Section II shows the literature review in terms of ergonomics, OHSMS, and accidents at work. Section III provides the details on the research methodology, which will cover research design, sample, measures, and data analysis procedure in using SEM. Section IV shows the results of empirical analysis in terms of the evaluation of the measurement model, testing the structural model, and hypothesis testing. Section V draws the results on the theories and previous studies, and covers theoretical implications and practical implications. Finally, Section VI closes this report by concluding key discoveries and outlining restrictions and next steps.

LITERATURE REVIEW

Research on occupational health and safety has increasingly focused on the issue of ergonomic design. In the high-risk construction industry, ergonomic design plays an important role in maximizing the compatibility between people, tools, environment, and work tasks. Construction industry workers are constantly faced with uncomfortable postures, repetitive movements, high workload, heavy object lifting, transportation, manual handling of materials, and a dynamic and unpredictable work environment, which pose risks to health such as musculoskeletal disorders, fatigue, and poor concentration, resulting in accidents in the workplace [8][18]. Beyond injuries, Poor working conditions resulting from ergonomic designs have been shown to lead to unsafe behavior and reduce compliance with safety regulations, increasing the risk of workplace accidents [5][20]. The results of empirical studies demonstrate that ergonomic aids such as workstation modification, workload sharing, ergonomic tool applications, and body posture training programs can help reduce the number of accidents and increase productivity in construction workplaces. Furthermore, advances such as the development of wearable devices to monitor ergonomic work postures and human-centered workplace technologies enable real-time identification of occupational hazards and accidents [10]. It can be concluded that the impact of ergonomic design on worker safety is essential. However, most of the studies to date focus on physical harm reduction and workers' comfort, and pay insufficient attention to the broader organizational context of safety, so ergonomic design alone is not enough to fully avoid accidents when the safety culture, management, and supervision are insufficient [3][7].

The Occupational Health and Safety Management System (OHSMS) is a formalized system used by organizations to identify and manage hazards, reduce risks, promote a culture of safety, and encourage participation in and compliance with safety rules. OHSMS is important to construction enterprises because of the complex construction project environment, numerous stakeholders, and variable working conditions [9]. Numerous empirical studies have shown that effective adoption and application of OHSMS have significantly reduced accident rates, enhanced safety management practices, and cultivated a positive safety culture among employees [2][6]. Despite its benefits, most enterprises in developing countries implement OHSMS solely to fulfill regulatory requirements, placing the emphasis on formal documentation rather than humanistic safety considerations.

However, most of the previous studies regarded ergonomic design and OHSMS as independent issues and did not deeply investigate their combined influence on construction worker safety outcomes. The role of mediation mechanisms has been discussed in recent literature in terms of how the interventions influence accident outcomes. Ergonomic design may not only directly reduce accidents but also indirectly impact worker safety by strengthening organizational safety mechanisms, improving worker awareness and safe participation, and enhancing safety compliance [12]. Therefore, in the present study, we propose an integrated theoretical model in which OHSMS plays a mediating role between ergonomic design and workplace accident using Structural Equation Modeling (SEM).

Hypothesis Development

- H1: Positive impact of Ergonomic Design on the effectiveness of OHSMS
- H2: Negative impact of Ergonomic Design on workplace accidents.
- H3: Negative impact of OHSMS on workplace accidents.
- H4: OHSMS mediates the relation between Ergonomic Design and Workplace Accidents.

METHODS

Research Design

The present study adopted a quantitative approach by employing a survey design to explore the mediating effect of OHSMS in the association between ergonomic design and workplace accidents within the construction industry. According to Sarstedt et al., (2021), it would be appropriate to adopt a quantitative approach for examining the associations amongst the constructs since the study seeks to test the existence of causal relationships using SEM. SEM has been commonly applied in ergonomics and occupational safety studies due to its ability to concurrently assess structural and measurement models [20]. For this study, construction workers engaged in building construction projects in Bali, Indonesia, were selected as research respondents. The choice of construction workers was based on the direct experiences that these individuals have regarding ergonomics and work accidents.

Population and Sample

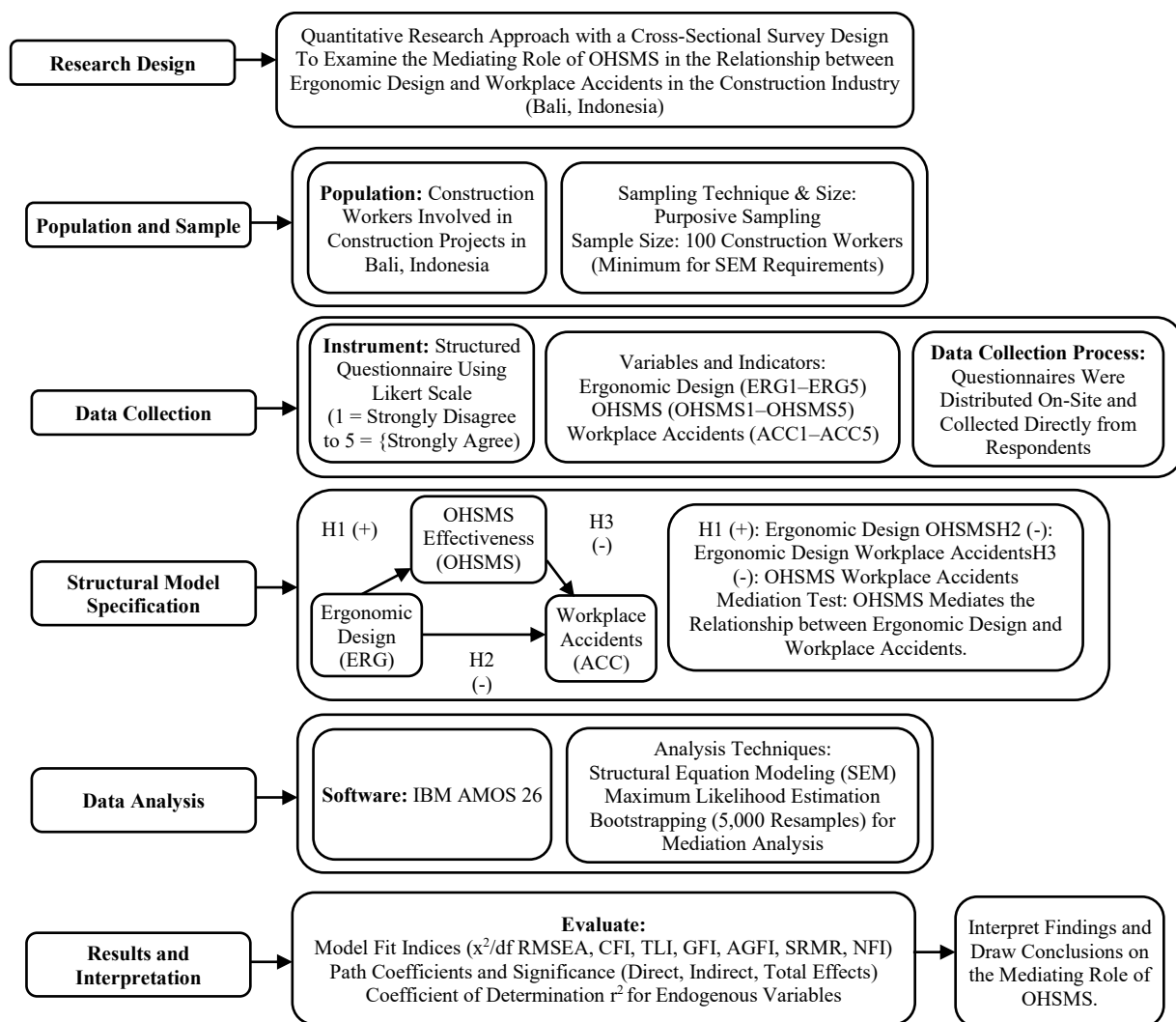


Figure 1. Research methodology framework for ergonomic design, OHSMS, and workplace accidents

The participants in this study were construction workers involved in building projects in Bali Province of Indonesia. Purposive sampling was utilized as the sampling technique since all workers do not have adequate knowledge and experience regarding ergonomic procedures and OHSMS. Purposive sampling enables the researcher to choose the subjects based on specified criteria [6].

Figure 1 presents the research design employed in this study. The research design begins with quantitative cross-sectional survey design and concludes with the selection of a sample of 100 construction workers in Bali. This includes the collection of data using a well-formulated questionnaire based on the Likert scale, validation of the measurement model through confirmatory factor analysis, and test of the structural model through structural equation modeling using AMOS. In addition, mediation analysis will be conducted to test the influence of OHSMS on the relationship between ergonomic design and workplace accidents. Tests of hypotheses through bootstrapping and validation of the research model will be conducted too, as illustrated by the figure 1 above.

Respondents Must Have At least Three Years of Experience in Construction Work

The sample size was calculated by taking into account the recommendations about SEM analysis set out in Sarstedt et al., (2021), which indicate that the minimum number of respondents needed for SEM should be 100-200, contingent upon the degree of model complexity, number of indicators, and estimation methods applied. Since this paper had three latent variables and a number of indicator measures, 100 respondents were considered adequate to obtain valid SEM results and test the hypothesis proposed. The recommended number of respondents was also evaluated according to Cochran's formula with the confidence level of 95% and an error margin of 10%. This evaluation indicated that the minimum number of participants required was 96. To ensure reliability and validity of the obtained results, 100 participants were used as the sample. Respondents were selected across all the nine regions of Bali including Denpasar, Gianyar, Badung, Tabanan, Karangasem, Buleleng, Jembrana, Bangli, and Klungkung.

Data Collection Procedures

Primary and secondary sources of data have been used for this research. Primary data has been gathered via a structured survey questionnaire that was issued to construction workers either in a face-to-face form or online. This questionnaire comprised questions related to ergonomic design, OHSMS adoption, and incidents at workplaces. Secondary data comprised information about occupational accidents, safety standards, existing literature, and earlier research on ergonomic and occupational safety management in the construction sector. Before mass administration, the questionnaire was piloted to assess its reliability and validity. Additionally, observations and interviews were undertaken with practitioners working on construction projects. All questions in the survey questionnaire were based on a five-point Likert scale with values ranging from 1 ("strongly disagree") to 5 ("strongly agree").

Common Method Bias Test

As all the information from the study was obtained using self-reporting questionnaires, the Common Method Bias (CMB) test was performed using the Harman's Single Factor Test. As Podsakoff et al., (2012) explain, common method bias is present if only one factor accounts for more than 50% of the total variance [14]. The results of Harman's single factor test revealed that the first factor accounted for less than 50% of the total variance; thus, the problem of common method bias was not relevant in this research.

Bootstrapping Procedure

For the purposes of testing the influence of the OHSMS on the mediating effect of ergonomics between ergonomics and occupational accident, a bootstrapping procedure was conducted using 5,000 resamples. The procedure is a well-established technique to be used in mediation analyses since it does not depend on assumptions regarding normality of indirect effects distribution [11]. If the confidence

interval obtained through bootstrapping did not contain zero, while the p-value was smaller than 0.05, the mediating effect was considered significant.

Validity and Reliability Testing

Construct validity was evaluated using Confirmatory Factor Analysis (CFA), including:

- Convergent validity
- Discriminant validity

Convergent validity was assessed using factor loading values (>0.50) and Average Variance Extracted (AVE >0.50). For the purpose of reliability testing, the following was used:

- Composite Reliability (CR >0.70)
- Cronbach's Alpha (>0.70)

This would suggest that latent variables have good enough reliability and internal consistency [11].

Ethical Considerations

All ethical practices of conducting research on human subjects were adhered to during this study. All participants were fully informed of the research objectives, of their own choice to participate or not, of how their information will be maintained confidentially, and that they could withdraw from the study whenever they wished without any penalties. Prior to conducting the survey, each subject agreed to participate voluntarily in this study. The study received official endorsement by the Institutional Research Ethics Committee of Civil Engineering, Politeknik Negeri Bali.

RESULTS

Respondent Characteristics

In total, there were 100 construction workers involved in this study. The subjects were randomly selected from several construction sites in Bali, Indonesia, located in such districts as Denpasar, Badung, Gianyar, Tabanan, Karangasem, Bangli, Buleleng, Jembrana, and Klungkung. All respondents met the predetermined sampling criteria, namely being at least 18 years old, having All of the respondents have at least three years of working experience in the construction industry and have an elementary understanding of OHSMS. The demographic characteristics of the respondents are provided below in table 1.

Table 1. Demographic characteristics of respondents (n = 100)

Characteristics	Category	Frequency	Percentage (%)
Age	20–30 years	24	24.0
	31–40 years	38	38.0
	41–50 years	27	27.0
	>50 years	11	11.0
Work Experience	3–5 years	29	29.0
	6–10 years	41	41.0
	11–15 years	20	20.0
	>15 years	10	10.0
Job Position	Construction laborer	37	37.0
	Technician/operator	24	24.0
	Foreman/supervisor	21	21.0
	Site engineer/project staff	18	18.0
Education Level	Junior high school	14	14.0
	Senior high school/vocational school	58	58.0
	Diploma	18	18.0
	Bachelor's degree	10	10.0

The respondent profile indicates that the majority of participants in table 1 were in the productive working-age group of 31–40 years (38%), followed by workers aged 41–50 years (27%). This distribution reflects the dominant age composition commonly found in labor-intensive construction projects in Indonesia, where physically demanding work activities are primarily performed by workers within productive age categories. The demographic distribution demonstrates that the research sample adequately represents the characteristics of construction workers involved in labor-intensive building projects in Bali, Indonesia. Therefore, the respondents were considered appropriate for examining the relationships among ergonomic design, Occupational Health and Safety Management Systems (OHSMS), and workplace accidents in the construction industry.

SEM Assumption Testing

Before conducting Structural Equation Modeling (SEM) analysis, several statistical assumptions were evaluated to ensure data suitability for model estimation. The assumption tests included normality, linearity, homoscedasticity, and multicollinearity. The results are presented in table 2.

Table 2. SEM assumption test results

Assumptions	Statistical Tests	Test Value	Criteria	Decision
Normality	Kolmogorov–Smirnov/Shapiro–Wilk	p = 0.078	p > 0.05	Meets assumption
	Skewness/Kurtosis	0.25 / 1.55	Skewness < ±2; Kurtosis < ±7	Meets assumption
Linearity	Linearity Test	F = 15.62	p < 0.05	Meets assumption
Homoscedasticity	Glejser Test	p = 0.284	p > 0.05	Meets assumption
Multicollinearity	VIF	1.20–3.00	VIF < 5	Meets assumption

Since the p-value of 0.078 for the Kolmogorov-Smirnov and Shapiro-Wilk test was greater than 0.05, the results proved that the data followed a normal distribution pattern. Skewness and kurtosis values fell under acceptable limits, implying that the data passed the assumptions for multivariate normality. The results further revealed that the assumptions of linearity, homoscedasticity, and multicollinearity were fulfilled, making the data fit for SEM analysis.

Measurement Model Evaluation

Measurement Model Testing was done using Confirmatory Factor Analysis (CFA) to assess Convergent Validity and reliability of the construct. Table 3 presents the results of the CFA analysis.

Table 3. Confirmatory factor analysis results

Latent Variable	Indicator	Loading Factor	AVE	CR	Cronbach's Alpha	Information
Ergonomic Design (ERG)	ERG1	0.78	0.63	0.89	0.85	Valid & Reliable
	ERG2	0.81				
	ERG3	0.76				
	ERG4	0.74				
	ERG5	0.79				
OHSMS	OHSMS1	0.82	0.67	0.90	0.87	Valid & Reliable
	OHSMS2	0.85				
	OHSMS3	0.79				
	OHSMS4	0.77				
	OHSMS5	0.80				
Workplace Accidents (ACC)	ACC1	0.83	0.66	0.88	0.84	Valid & Reliable
	ACC2	0.79				
	ACC3	0.81				
	ACC4	0.77				
	ACC5	0.80				

The factor loadings of ERG1-ERG5 on Ergonomic Design, OHSMS1-OHSMS5 on OHSMS, and ACC1-ACC5 on Workplace Accidents had values above 0.70, meaning that these constructs were reliable indicators. The AVE values for all the constructs ranged from 0.63 to 0.67, which exceeds the threshold of 0.50 that is considered acceptable, hence convergent validity. The values of CR and Cronbach's Alpha for all three latent variables were above 0.70.

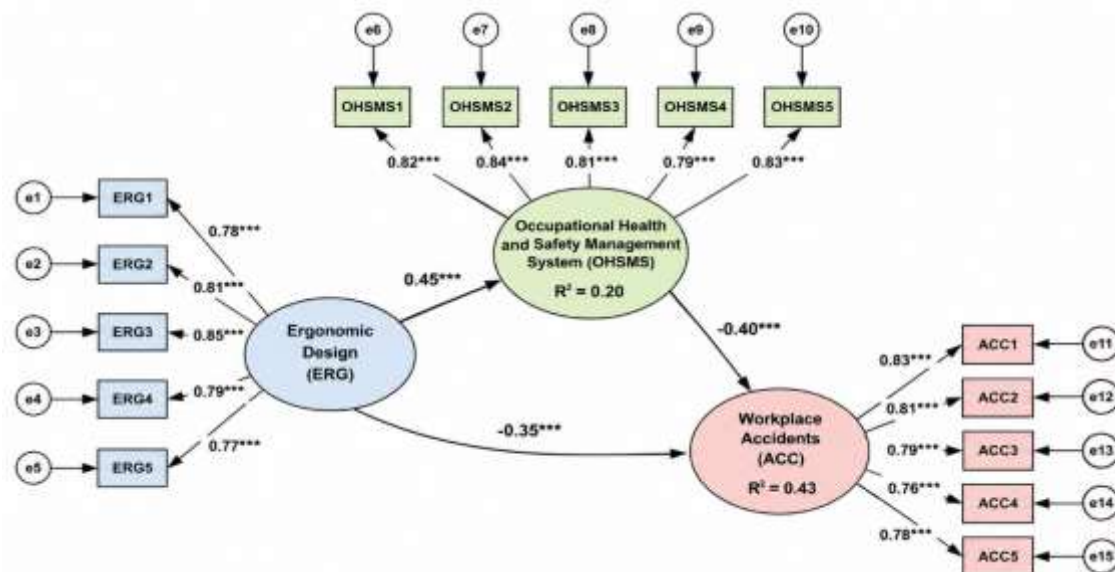


Figure 2. Structural equation model of ergonomic design, OHSMS, and workplace accidents with standardized estimates

Figure 2 shows the SEM with the relationship between ERG and ACC through OHSMS. Standardized loadings of the factor, paths, and significance values are shown. R^2 values for the endogenous factors are displayed. The paths representing both direct and indirect effects are also displayed in the model. The model results reveal that OHSMS mediates to reduce accidents.

Structural Model Evaluation

Path coefficients, the coefficient of determination (R^2), effect size (f^2), predictive relevance (Q^2), and bootstrapping were used to examine the structural model. The model fitness results indicate that the model fit indices had appropriate goodness-of-fit, as depicted in table 4.

Table 4. Goodness-of-Fit indices

Goodness-of-Fit Index	Cut-off Value	Result	Conclusion
Chi-Square (χ^2)	$p > 0.05$	$\chi^2 = 128.45, df = 112, p = 0.072$	Good Fit
RMSEA	≤ 0.08	0.045	Good Fit
CFI	≥ 0.90	0.96	Good Fit
TLI	≥ 0.90	0.94	Good Fit
GFI	≥ 0.90	0.92	Good Fit
AGFI	≥ 0.90	0.91	Good Fit
SRMR	≤ 0.08	0.039	Good Fit
NFI	≥ 0.90	0.93	Good Fit

Since all the goodness-of-fit indices indicated that the model fits the data, the structure is statistically sound for hypothesis testing.

Coefficient of Determination (R^2)

R^2 was calculated to estimate the ability of the endogenous constructs to explain the results.

The findings are displayed in table 5 below.

Table 5. Coefficient of determination (R^2)

Endogenous Variable	R^2	Interpretation
OHSMS	0.45	Moderate
Workplace Accidents (ACC)	0.53	Moderate–Substantial

The R^2 value of 0.45 indicates that Ergonomic Design explains 45% of the variance in OHSMS effectiveness. Meanwhile, Ergonomic Design and OHSMS collectively explain 53% of the variance in Workplace Accidents, indicating moderate-to-substantial explanatory power.

Effect Size (f^2)

The effect sizes analysis was carried out in order to determine the effect of each exogenous construct on the endogenous variables. The findings are presented in table 6.

Table 6. Effect size (f^2)

Relationship	f^2	Effect Size
ERG $\rightarrow$ OHSMS	0.29	Medium
ERG $\rightarrow$ ACC	0.21	Medium
OHSMS $\rightarrow$ ACC	0.31	Large

According to the analysis of the effect size, the impact of Ergonomic Design on OHSMS effectiveness and Workplace Accidents is moderate, whereas the impact of OHSMS on Workplace Accidents is large.

Predictive Relevance (Q^2)

Predictive relevance was checked using a blindfolding procedure. Q^2 values are shown in table 7 below.

Table 7. Predictive relevance (Q^2)

Endogenous Variable	Q^2	Interpretation
OHSMS	0.31	Predictive Relevance
Workplace Accidents (ACC)	0.38	Predictive Relevance

All the Q^2 values were above zero, showing that the structural model has sufficient predictive relevance for the endogenous variables.

Hypothesis Testing and Bootstrapping Results

The test of hypotheses was done via bootstrapping using 5,000 re-samples and a 95% confidence interval. Standardized path coefficient values, t-ratios, p-values, and confidence intervals are shown in table 8 below.

Table 8. Structural path analysis and bootstrapping results

Hypothesis	Path Relationship	Standardized Coefficient (β)	t-value	p-value	95% Confidence Interval	Decision
H1	ERG $\rightarrow$ OHSMS	0.45	6.32	0.000	[0.312, 0.581]	Supported
H2	ERG $\rightarrow$ ACC	-0.35	-4.85	0.000	[-0.492, -0.218]	Supported
H3	OHSMS $\rightarrow$ ACC	-0.40	-5.27	0.000	[-0.544, -0.267]	Supported
H4	ERG $\rightarrow$ OHSMS $\rightarrow$ ACC	-0.18	-3.92	0.000	[-0.301, -0.102]	Supported

These findings show that Ergonomic Design has a significant positive effect on OHSMS effectiveness ($\beta = 0.45$, $p < 0.001$). Moreover, Ergonomic Design exhibits a significant negative association with Workplace Accidents ($\beta = -0.35$, $p < 0.001$), supporting H2. Furthermore, OHSMS significantly reduces Workplace Accidents ($\beta = -0.40$, $p < 0.001$), supporting H3.

Mediation results show that OHSMS significantly mediates the impact of Ergonomic Design on Workplace Accidents ($\beta = -0.18$, $p < 0.001$). Considering that the confidence intervals did not cover the value of zero, the indirect impact was found to be statistically significant, thus confirming the validity of H4. The total effect of Ergonomic Design on Workplace Accidents is estimated at $\beta = -0.53$. It means that the impact of ergonomic design on the reduction of accidents in the workplace can be significant both directly and indirectly by improving OHSMS performance.

DISCUSSION

"This study reveals that integrating ergonomic design into the Occupational Health and Safety Management Systems (OHSMS) is crucial to prevent workplace accidents in construction industries. Ergonomic design is not simply about making employees feel comfortable; instead, it is an organizational tool that influences safety performance by supporting the human level as well as system-level processes," said Puteri. "Workplace accidents are multifaceted and driven by several complex factors interacting: the workplace system, organizational safety processes, worker behaviors, and working environments." "In essence, our study is grounded in the theory of human factors and explains that an accident occurs when a working system doesn't fit with human abilities, either physically or psychologically. In labor-intensive construction sectors, the workers undergo repeated physical work with strenuous loads, inappropriate posture, and often fluctuating environmental working conditions. This may cause worker fatigue and mental stress, leading to a failure to demonstrate safe behavior." "Our study demonstrates how ergonomic design effectively enables better adaptation and more desirable behavior of workers, thus preventing accidents. Further contributions of this study were to provide additional insight into the effect of ergonomics design on the organization's safety process, such as safety awareness, participation, and adherence, instead of the previous research, which only focused on the reduction of injuries, hence providing additional argument that ergonomic design must become part of the safety organization process. The mediating role of OHSMS in translating ergonomic design intervention to workplace safety outcomes is another valuable contribution in this study, where the better implementation of OHSMS can lead to enhanced communication, supervision, hazard reporting, and employee engagement, which in turn leads to reduced work-related accidents based on Systems theory and the Swiss cheese model. Practically, the results imply that construction firms must systematically integrate ergonomic assessments in their OHSMS processes, reinforce safety culture and practice, and use progressive safety management methods. However, limitations of this study include the scope, which is limited to the construction industry and focuses only on projects located in Bali. Due to its cross-sectional data, the study also cannot establish any cause-and-effect relationships. Future study is required using data over time, larger samples, and further study is warranted to investigate variables, such as safety leadership or psychological safety."

CONCLUSION

The purpose of this study was to analyze the mediating effect of Occupational Health and Safety Management Systems (OHSMS) between ergonomic design and accidents in the construction industry in Bali, Indonesia. The results revealed that ergonomics has been identified as positively influencing and significantly reducing accident occurrences due to an improvement in ergonomics and improved OHSMS implementation. It indicates that ergonomic design improved OHSMS implementation, where good workplace layout, adjustable work time, ergonomic tools, and proper workers' postures make an impact on the safety implementation of the construction site. Furthermore, both ergonomic design and OHSMS improve and significantly reduce accidents on the job. A mediating effect was also revealed as OHSMS mediates ergonomic design to reduce accidents in the workplace. Thus, accident reduction is not solely a physical condition or ergonomic design factor, but also needs good organization in safety management. The results support Human Factors Theory and Systems Theory, where the accident resulted from the interactions of a set of physical, technical, and organizational systems elements. As practical implications, the study concludes that Ergonomics design needs to be incorporated into an OHSMS implementation to make workplace accidents in construction companies more sustainable. Strengthening the elements of safety training and supervision, hazard assessment, and worker participation helps the success of ergonomics design in practice. Although the result of this study was conducted for 100 respondents from workers on the construction site in Bali, it could give some very

useful findings for developing countries. In the end, the study concludes that ergonomics design integrated into OHSMS could provide benefits as an important tool in reducing the number of accidents on the job in the construction industry sustainably.

Acknowledgements

The authors would like to express their sincere gratitude to the construction workers, project managers, and construction companies in Bali, Indonesia, who participated in and supported this research. The authors also appreciate the support provided by the Civil Engineering Department, Politeknik Negeri Bali, for facilitating the research process and academic discussions. Special thanks are extended to all colleagues and reviewers whose valuable suggestions contributed to the improvement of this study.

Declaration of Conflict of Interest

The authors do not report any conflict of interest in the publication of this article. Authors state that this study was carried out without commercial, financial, personal or other affiliations that could impact this study.

REFERENCES

- [1] Alshammari TM, Rabi M, Al-Kheetan MJ, Alkherret AJ. The influence of managers' safety perceptions and practices on construction workers' safety behaviors in Saudi Arabian projects: The mediating roles of workers' safety awareness, competency, and safety actions. *Safety*. 2025 Aug 5;11(3):77. <https://doi.org/10.3390/safety11030077>
- [2] Bautista-Bernal I, Quintana-García C, Marchante-Lara M. Safety culture, safety performance and financial performance. A longitudinal study. *Safety science*. 2024 Apr 1;172:106409. <https://doi.org/10.1016/j.ssci.2023.106409>
- [3] Bourahla A, Fernandes G, Ferreira LM. Managing occupational health and safety risks in construction projects to achieve social Sustainability—A review of literature. *Procedia Computer Science*. 2024 Jan 1;239:1053-61. <https://doi.org/10.1016/j.procs.2024.06.269>
- [4] Bria TA, Chen WT, Muhammad M, Rantelembang MB. Analysis of fatal construction accidents in Indonesia—a case study. *Buildings*. 2024 Apr 5;14(4):1010. <https://doi.org/10.3390/buildings14041010>
- [5] Chan AP, Guan J, Choi TN, Yang Y, Wu G, Lam E. Improving safety performance of construction workers through learning from incidents. *International journal of environmental research and public health*. 2023 Mar 4;20(5):4570. <https://doi.org/10.3390/ijerph20054570>
- [6] Rafsanjani HN, Nabizadeh AH. Towards human-centered artificial intelligence (AI) in architecture, engineering, and construction (AEC) industry. *Computers in Human Behavior Reports*. 2023 Aug 1;11:100319. <https://doi.org/10.1016/j.chbr.2023.100319>
- [7] Claxton G, Hosie P, Sharma P. Toward an effective occupational health and safety culture: A multiple stakeholder perspective. *Journal of safety research*. 2022 Sep 1;82:57-67. <https://doi.org/10.1016/j.jsr.2022.04.006>
- [8] Rahman MH, Ghasemi A, Dai F, Ryu J. Review of emerging technologies for reducing ergonomic hazards in construction workplaces. *Buildings*. 2023 Nov 28;13(12):2967. <https://doi.org/10.3390/buildings13122967>
- [9] Feng Y, Teo EA, Ling FY, Low SP. Exploring the interactive effects of safety investments, safety culture and project hazard on safety performance: An empirical analysis. *International journal of project management*. 2014 Aug 1;32(6):932-43. <https://doi.org/10.1016/j.ijproman.2013.10.016>
- [10] Park JH, Banarjee C, Fu J, White-Williams C, Coel R, Zaslow T, Benjamin H, Silva F, Vomer R, Pujalte G. Youth athletes and wearable technology. *F1000Research*. 2024 Nov 18;13:1381. <https://doi.org/10.12688/f1000research.156207.1>
- [11] Sarstedt M, Ringle CM, Hair JF. Partial least squares structural equation modeling. In *Handbook of market research 2021* Dec 3 (pp. 587-632). Cham: Springer International Publishing. https://doi.org/10.1007/978-3-319-57413-4_15
- [12] Li Y, Gao J, Qian C, Wu X. The mediation role of safety attitude in the impact of resilience on the safety behavior of coal miners in China. *International journal of environmental research and public health*. 2022 Nov 17;19(22):15164. <https://doi.org/10.3390/ijerph192215164>
- [13] Ponce P, Maldonado-Romo J, Anthony BW, Bradley R, Montesinos L. A Symbiotic Digital Environment Framework for Industry 4.0 and 5.0: Enhancing Lifecycle Circularity. *Eng*. 2025 Dec 6;6(12):355. <https://doi.org/10.3390/eng6120355>

- [14] Podsakoff PM, MacKenzie SB, Podsakoff NP. Sources of method bias in social science research and recommendations on how to control it. *Annual review of psychology*. 2012 Jan 10;63(1):539-69. <https://doi.org/10.1146/annurev-psych-120710-100452>
- [15] Purnomo DA, Prisilia H. Analysis of occupational safety and health in the construction project of integrated lecture building. *G-Tech: Jurnal Teknologi Terapan*. 2025 Jan 10;9(1):296-303. <https://doi.org/10.70609/gtech.v9i1.6108>
- [16] Chellappa V, Luximon Y. Computer-aided technologies for posture-based ergonomic risk assessment in construction: A systematic review. *International Journal of Construction Management*. 2026 Jan 25;26(2):316-31. <https://doi.org/10.1080/15623599.2025.2520880>
- [17] Teperi AM, Paajanen T, Asikainen I, Lantto E. From must to mindset: Outcomes of human factor practices in aviation and railway companies. *Safety science*. 2023 Feb 1;158:105968. <https://doi.org/10.1016/j.ssci.2022.105968>
- [18] Trstenjak M, Benešova A, Opetuk T, Cajner H. Human factors and ergonomics in industry 5.0—a systematic literature review. *Applied Sciences*. 2025 Feb 17;15(4):2123. <https://doi.org/10.3390/app15042123>
- [19] Wooldridge AR, Carman EM, Xie A. Human Factors and Ergonomics (HFE) applications in responses to the COVID-19 pandemic: Lessons learned and considerations for methods. *Applied Ergonomics*. 2022 Jul 1;102:103733. <https://doi.org/10.1016/j.apergo.2022.103733>
- [20] Zhang Z, Li H, Guo H, Wu Y, Luo Z. Causal inference of construction safety management measures towards workers' safety behaviors: A multidimensional perspective. *Safety science*. 2024 Apr 1;172:106432. <https://doi.org/10.1016/j.ssci.2024.106432>