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Awareness Consistency vs. Facility Contextuality: Determinants of Students' OSH Discipline in an Engineering Education Environment

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Abstract

Technical education encompasses diverse practical learning environments, suggesting that occupational safety and health implementation depends heavily on specialized laboratory characteristics. This study investigates the behavioral determinants of safety discipline among engineering students and analyzes whether these relational patterns diverge across different academic departments. Utilizing an ex post facto quantitative design, researchers gathered data from 363 active participants selected through proportionate stratified sampling across four distinct study programs. Multiple linear regression and univariate covariance analysis evaluated the influence of safety awareness, motivation, and facility support on compliance. The regression models revealed that predictors account for 28.0 percent of the compliance variance in mechanical engineering and 24.9 percent in electrical disciplines. The advanced covariance analysis confirmed that intrinsic awareness and motivation maintain absolute statistical consistency across all groups. However, external facility support exhibits a highly significant contextual dependency with an interaction probability value of 0.002. These comparative findings indicate that psychological safety drivers remain universally stable, whereas physical infrastructure reliance heavily depends on specific departmental hazards. Institutional administrators must therefore centralize psychological training while decentralizing physical hazard controls.

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Introduction

Engineering education relies heavily on practical learning experiences in workshops where students apply theoretical knowledge to actual operations. These environments expose individuals to various occupational hazards including mechanical risks and electrical dangers. Consequently, implementing occupational safety and health protocols is necessary to protect students and build safety competencies before they enter the workforce. Current scholarship establishes that safety discipline depends on intrinsic and extrinsic determinants. Rusyda & Abdul Aziz (2021) emphasize that internal aspects like safety awareness and personal motivation drive proactive safe behaviors. Simultaneously, external elements such as adequate facility support create an enabling environment for compliance (Murugiah et al., 2025). Combining human factors with physical infrastructure remains the foundation of effective safety management.

Despite extensive literature on safety compliance, a notable limitation exists in how previous researchers approach student populations. Most studies analyze technical students as a single uniform entity while ignoring the diverse nature of practical environments across different academic concentrations. Civil construction, electrical experiments, mechanical manufacturing, and culinary arts present entirely distinct risk profiles. Therefore, the relationship between safety awareness, motivation, facility support, and safety discipline might not be identical across these fields. Sukri et al. (2023) argue that generic safety interventions often fail in highly specialized laboratory environments. Exploring whether the influence of these determinants remains consistent or fluctuates depending on departmental characteristics remains largely untouched in recent literature (Carissa et al., 2025). Understanding this variation holds critical value because specialized facilities demand tailored approaches.

Addressing this empirical void, this study investigates the determinants of occupational safety and health discipline among students within a diverse academic environment. The primary objective is to analyze the relationship patterns between safety awareness, safety motivation, and facility support toward safety discipline. This research also identifies whether these relational patterns differ significantly across four distinct departments at the Faculty of Engineering, Universitas Negeri Malang. Pilbeam & Karanikas (2023) suggests that comparing diverse groups helps determine if internal behavioral drivers remain consistent across disciplines while external facility requirements exhibit contextual dependency. The findings will provide targeted insights for developing tailored safety management strategies that align with specific program needs, thereby improving overall institutional safety culture (Ajmal et al., 2021)

Methods

This study employed a quantitative ex post facto research design to investigate the determinants of occupational safety and health discipline among engineering students. Creswell & Creswell (2018) explicitly states that this specific design serves as an optimal strategy to examine variables objectively without directly manipulating the research subjects. The research took place at the Faculty of Engineering, Universitas Negeri Malang, involving active students from the academic years 2023 through 2025 who had completed practical laboratory courses. From a total population of 3,970 individuals, the researchers selected 363 participants utilizing a proportionate stratified sampling technique to guarantee balanced representation across various academic disciplines (Babbie, 2013). The precise distribution of these participants across the four academic departments is visually illustrated in Figure 1. Data collection utilized a survey measuring four constructs through 38 items on a 4 points

Likert scale. The constructs included safety awareness, safety motivation, facility support, and safety discipline. Prior to actual data collection, the instrument underwent rigorous empirical testing to confirm its validity via Pearson correlation and established strong reliability with Cronbach Alpha coefficients exceeding standard acceptability thresholds.

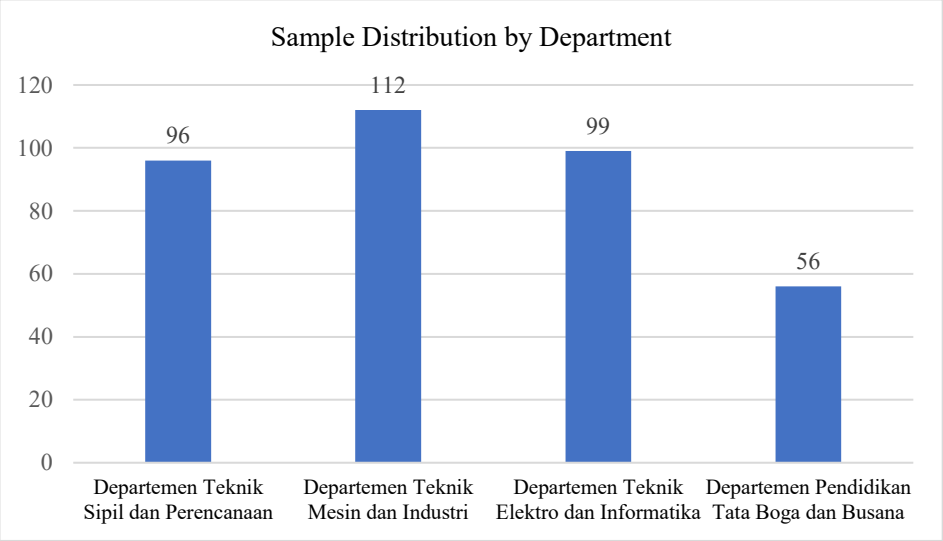

Figure 1. Distribution of the Sample Based on Departments

The quantitative data analysis proceeded in two primary stages to address the research objectives comprehensively. During the initial stage, researchers applied multiple linear regression separately for each department to map the predictive influence of safety awareness, motivation, and facility support on safety discipline. According to Sarstedt (2019), utilizing the adjusted R squared metric is essential for accurately evaluating the capability of explanatory variables in describing the model variance. Subsequently, the study utilized Univariate Analysis of Covariance to examine structural differences across the academic groups. In this advanced procedure, the department functioned as the main factor while the three independent variables served as covariates. Analyzing the interaction effects between the department factor and each covariate allowed the researchers to determine whether the determinants of safety behavior differed significantly across various vocational environments (Field, 2009). All statistical hypothesis testing was systematically executed by setting the significance threshold at 5%.

Results and Discussions

1. Results

a. Regression Analysis Based on Departmental Groupings

The multiple linear regression analysis was conducted separately for each academic department to evaluate how safety awareness, safety motivation, and facility support influence students occupational safety discipline. A detailed summary of the unstandardized beta coefficients, significance values, and adjusted R squared metrics for all four groups is systematically presented in Table 1. The adjusted R squared values indicate the explanatory power of the predictive model within each field of study. Specifically, the independent variables account for 19.5% of the variance in the Civil Engineering and

Planning Department, and 24.9% in the Electrical Engineering and Informatics Department. Furthermore, the model explains 28.0% of the variance in the Mechanical and Industrial Engineering Department, while accounting for 25.8% in the Culinary Arts and Fashion Education Department.

Table 1. Multiple Linear Regression Results Based on Department

Department	Safety Awareness		Safety Motivation		Facility Support		Adjusted R2
	B	Sig.	B	Sig.	B	Sig.	
DTSP	0.287	0.098	0.388	0.009	0.037	0.800	0.195
DTEI	0.080	0.642	0.412	0.001	0.299	0.022	0.249
DTMI	0.192	0.430	0.315	0.018	0.638	0.000	0.280
DPTBB	0.671	0.007	0.239	0.243	0.094	0.573	0.258

Note: The influence is considered significant when the Sig value is less than 0.05.

Examining the specific predictors reveals distinct relational patterns for the internal behavioral drivers across different educational environments. Safety awareness demonstrates a statistically significant positive influence exclusively within the Culinary Arts and Fashion Education Department, recording a beta coefficient of 0.671 and a significance value of 0.007. In contrast, this awareness construct fails to reach statistical significance in the civil, electrical, and mechanical departments. Conversely, safety motivation exhibits an entirely different pattern by showing significant positive correlations within the three engineering disciplines. The motivation variable acts as a significant predictor in the civil department with a significance of 0.009, the electrical department at 0.001, and the mechanical department at 0.018. However, motivation lacks statistical significance in the culinary and fashion group, showing a significance value of 0.243.

Regarding the external variable, the analysis highlights that physical facility support plays a highly specific role depending on the technical discipline. Table 1 clearly illustrates that facility support significantly predicts safety compliance in the Electrical Engineering and Informatics Department with a beta value of 0.299 and a significance of 0.022. This external factor becomes even more prominent in the Mechanical and Industrial Engineering Department, yielding a strong beta coefficient of 0.638 and a highly significant value of 0.000. Conversely, facility provision shows no meaningful statistical correlation with safety discipline in the civil engineering environment at 0.800 or the culinary arts program at 0.573. These fluctuating coefficients provide preliminary descriptive evidence that the determinants of occupational safety behaviors vary depending on the specific characteristics of each academic program.

b. Comparative Analysis Results Based on Departmental Environment

The Univariate Analysis of Covariance was systematically applied to determine whether the relationships between the predictive variables and safety discipline significantly diverge across different academic environments. While initial regression models revealed visible fluctuations, those descriptive variations require advanced statistical validation to confirm structural differences among the groups. In this comparative evaluation, the academic department served as the fixed factor, whereas safety awareness, safety motivation, and facility support operated as covariates. The analytical focus primarily rests on the interaction effects between the department category and each specific covariate. A comprehensive summary of the F statistics, significance levels, and effect sizes is clearly presented in Table 2. Readers are directly guided to this table to observe the exact statistical metrics determining which behavioral drivers exhibit contextual dependency.

Table 2. Interaction Test Results Across Departments

Interaction	F	Sig.	Partial Eta Squared
Department with Safety Awareness	1.239	0.295	0.011
Department with Safety Motivation	0.222	0.881	0.002
Department with Facility Support	4.946	0.002	0.041

According to the statistical output detailed in the table, the interaction between the academic department and safety awareness fails to demonstrate a significant discrepancy across the educational fields. The analysis yielded an F value of 1.239 alongside a significance level of 0.295. Because this value considerably exceeds the 0.05 threshold, the evidence confirms that the relational pattern between internal safety awareness and safety discipline remains consistent regardless of the technical discipline. The partial eta squared value of 0.011 indicates a negligible effect size for this specific interaction. Consequently, despite earlier regression results showing awareness was only significant in the culinary program, the covariance analysis proves this relationship does not statistically differ from the engineering programs. Similarly, the statistical evaluation of safety motivation reveals a consistent structural relationship across all observed academic groups. Table 2 illustrates that the interaction involving the department factor and safety motivation produced an F statistic of 0.222 with a corresponding significance value of 0.881. This exceptionally high significance level definitively proves the absence of any meaningful variation among the student groups regarding how motivation influences safety compliance. Furthermore, the recorded partial eta squared metric of 0.002 represents an extremely weak interaction effect within the overall predictive model. Therefore, the internal drive to maintain personal safety operates as a universal behavioral determinant that transcends the unique characteristics of different laboratory settings.

In stark contrast to the internal behavioral constructs, external facility provision exhibits a highly contextual relationship with safety discipline. The interaction between the academic department and facility support generated an F value of 4.946 and a highly significant value of 0.002. Falling well below the strict 0.05 limit, this finding confirms a substantial divergence in how physical infrastructure affects safety compliance across distinct educational environments. The interaction effect size is also noticeably larger, evidenced by a partial eta squared value of 0.041, which indicates a meaningful contribution to the structural model. This conclusive statistical evidence verifies that reliance on physical safety infrastructure heavily depends on the specific operational risks inherent to each academic program.

2. Discussion

Statistical analysis reveals crucial insights regarding the structural determinants of student safety behavior in vocational engineering education. Although initial regression evaluations display descriptive fluctuations across departments, the univariate covariance test confirms that only external factors exhibit genuine relational divergence. The interaction between the academic department and facility support proves highly significant with a probability value of 0.002 and an interaction effect contribution of 0.041 within the structural model. Conversely, internal behavioral drivers including awareness and motivation show absolute uniformity across all academic groupings. These comparative findings contradict the traditional assumption that distinct study programs require entirely different psychological safety approaches. Instead, the evidence aligns with recent observations by Sayuti et al. (2024), who argue that

cognitive safety responses remain stable across diverse operational settings. Furthermore, physical environment availability plays a highly specific role depending on the inherent laboratory hazards, reinforcing the necessity for contextual infrastructure planning (Prasetya, 2025).

Examining the internal determinants more comprehensively demonstrates that safety awareness and motivation operate as universal constructs across all disciplines. The interaction test between departments and safety awareness yields a significance value of 0.295, while the motivation interaction records an exceptionally high value of 0.881. Because these probability figures far exceed the 0.05 tolerance limit, the statistical evaluation definitively proves the absence of structural relationship differences. Initial regression models noted that safety awareness appeared prominent primarily in the Culinary Arts and Fashion Education Department with a beta coefficient of 0.671 and a significance of 0.007, but the advanced testing nullifies this discrepancy at the broader population level. According to Han et al. (2022), the psychological drive to avoid workplace accidents functions as a fundamental self preservation mechanism regardless of the specific task. Culinary students facing thermal burn risks and civil engineering students handling heavy construction materials ultimately rely on similar intrinsic motivation levels before interacting with their practical equipment (Prasetya et al., 2025).

In stark contrast to psychological factors, facility support proves to be highly contextual and depends entirely on the operational characteristics of the practical tasks. The significance value of 0.002 in the univariate testing strongly reinforces the preceding regression outputs, where physical facility availability emerged as the most essential predictor in the Mechanical and Industrial Engineering Department with a significance of 0.000 and a coefficient of 0.638. Similar dependency appears within the Electrical Engineering and Informatics Department, registering a facility significance of 0.022 alongside a beta coefficient of 0.299. These operational conditions are perfectly logical because machining and electrical installation laboratories harbor severe hazards that organizations cannot control merely through human intention. Students operating high speed lathes or medium voltage panels absolutely require physical machine guards, exhaust ventilation systems, and highly specific protective equipment. Savolainen (2023) emphasize that in such elevated risk environments, safety discipline cannot materialize if the supporting physical infrastructure remains inadequate. This dependency on external safeguards is further validated by Ayi & Hon (2018), confirming that technical compliance relies heavily on environmental engineering controls.

The implications of these comparative findings provide a solid foundation for formulating targeted safety policies within technical education institutions. The reality that explanatory variables can account for 28.0 percent of the compliance variance in the mechanical department demonstrates the critical necessity of combining human interventions with environmental engineering. Faculty management does not need to design completely different safety motivation curricula for each department because the internal aspects of learners remain uniform across the board. Monteiro et al. (2020) recommend centralized safety culture training to establish baseline behavioral expectations efficiently. However, financial allocation and safety infrastructure design must be executed through a decentralized approach. Technical facility provision requires strict contextualization based on the specific risk profile of each laboratory to ensure that physical investments effectively address the exact hazards students face. Benson et al. (2024) assert that tailoring environmental support to specific operational demands represents the most effective strategy for sustaining continuous occupational compliance.

Conclusion

This research concludes that the structural determinants of students occupational safety discipline exhibit distinct operational patterns across different engineering education environments. While intrinsic behavioral drivers such as safety awareness and safety motivation demonstrate statistical consistency across all academic departments, external facility support shows significant contextual dependency with an interaction probability value of 0.002. The regression models further confirm this discrepancy by highlighting that mechanical and electrical engineering programs rely heavily on physical safeguards to achieve compliance, whereas culinary and civil disciplines operate independently of such infrastructural constraints. These findings deliver a critical implication for institutional safety management. Faculty administrators must implement centralized psychological training to build universal safety awareness while simultaneously deploying decentralized budget allocations tailored specifically to the unique infrastructural hazards of each laboratory setting. Future investigations should incorporate qualitative methodologies including observational assessments and student interviews to uncover the underlying sociological reasons why certain technical disciplines depend more heavily on external environmental controls than others.

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