

Analysis of BBS Factors and Development of Unsafe Action Guidelines at PT XYZ, Batam City

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Abstract

Introduction: The oil and gas fabrication industry has a high occupational accident risk due to welding, heavy lifting, working at heights, and hazardous material exposure. Behavior-Based Safety (BBS) is applied to control unsafe behaviors through behavioral interventions.

Objective: This study analyzed factors affecting unsafe action and developed prevention guidelines at PT XYZ, Batam City. **Method:** A cross-sectional mixed-method study involved 46 workers selected through total sampling.

Data were analyzed using univariate, Chi-Square, and multiple logistic regression analyses. **Results and Discussion:** Predisposing, enabling, and reinforcing factors were significantly associated with unsafe action ($p = 0.039$). Predisposing factor was the most dominant predictor (Wald = 5.281; $B = -0.506$; $p = 0.022$; OR = 0.603; 95% CI = 0.392–0.928), indicating a 39.7% reduction in unsafe action risk. **Conclusion:** Strengthening knowledge, attitudes, and OHS training is essential for developing BBS-based unsafe action prevention guidelines and improving workplace safety practices.

Introduction

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The oil and gas fabrication industry is one of the industrial sectors with a very high level of occupational safety risk (Phoon, 2022; Ramachandran & Kumar, 2021). The complexity of the production process involving extreme work such as welding, cutting, grinding, work at height, and heavy lifting (rigging and lifting) makes this sector very vulnerable to safety incidents (Priyadi & Wijaya, 2023). In Indonesia, the magnitude of this potential risk is reflected in BPJS Ketenagakerjaan data which recorded a significant increase in work accident cases, from 298,137 cases in 2022 to 370,747 cases in 2023, and has reached 356,383 cases until October 2024 (BPJS Ketenagakerjaan, 2024). Theoretically and practically, work accidents in industrial environments are multifactorial, which are the result of a complex interaction between unsafe working conditions, weaknesses in supervisory and organizational systems, and unsafe actions by workers (Shabani et al., 2024; Wiegmann & Shappell, 2017). Therefore, work accidents are not caused solely by a single factor, but rather as a result of a layered paralysis in the safety system (Swiss Cheese Model) where worker behavior is one of the crucial elements that is closest to the occurrence of the incident (Reason, 1990; Shabani et al., 2024).

PT XYZ Kota Batam is an international manufacturing and fabrication company that focuses on engineering oil and gas process systems and modular offshore facilities (PT XYZ, 2024). Among the various fabrication activities carried out, the type of work with the highest risk level is the operation of heavy lifting (rigging and lifting) of piping materials and module structures from the dock to the barge deck area (barge) as well as work at height (Priyadi & Wijaya, 2023). The high risk is evident from the company's incident record data in 2025, where there was a significant near miss incident in the main deck area of the barge near the M007 module. During the pipe material removal operation carried out by the rigging department and crane operators, the load suspended at height caused a small block on the crane to lose control until it hit an anti-two block device. The hard impact caused the crane pulley to detach and fall from a height of about 30 meters into the work area. Although it did not cause direct casualties or material damage, this near miss incident indicates a very real potential fatal hazard in the company's operations (OSHA, 2021; API, 2016).

Based on the results of initial observations and evaluation of safety reports in the PT XYZ fabrication area, the near miss incident and the potential hazard are closely related to the emergence of unsafe actions that are still found in workers in the field. Specific forms of unsafe actions identified in the initial observations include; Non-compliance and inappropriate or inconsistent use of Personal Protective Equipment (PPE), such as not using protective gloves, safety glasses, or full body harnesses when at height. Deviations from the Standard Operating Procedure (SOP) for operations and safety, including taking quick work steps (shortcuts) that skip official safety procedures, ignorance of potential occupational risks and misuse of machine safety devices, such as removing or deactivating safety devices on operational equipment; and

High-risk behaviors in work areas, such as jumping from stairs or work platforms, and lack of safety communication between team members during lifting operations. The high potential for danger due to the combination of extreme work risks and the existence of unsafe actions shows that the fulfillment of technical regulations and the availability of procedures alone are not enough to guarantee occupational safety if not balanced with behavior-based interventions (Geller, 2005; Hidayat & Syaifullah, 2022). The Behavior-Based Safety (BBS) approach offers a systematic framework based on behavioral psychology to identify, measure, and direct workers' behavior towards safe work practices through positive reinforcement and a structured observation system (Geller, 2001;

Cooper, 2021). To operationalize the control element of BBS, this study integrates the behavioral determinant theory framework of Green (1980) which groups behavior-forming factors into predisposing factors, enabling factors, and reinforcing factors. By focusing on real problems in PT XYZ Kota Batam, this study aims to identify forms of unsafe action that have the potential to trigger near miss, analyze the relationship and contribution of BBS factors to unsafe action of workers, and formulate the most relevant and effective BBS-based unsafe action prevention guidelines to be applied in the oil and gas fabrication environment of PT XYZ Kota Batam.

Method

This study uses a mix method approach as a quantitative and qualitative research design. This approach was chosen because the purpose of the study was to measure and analyze the relationship between independent variables (seven elements of *Behavior-Based Safety control*) and dependent variables (unsafe actions/risk behaviors and the likelihood of near accidents) statistically and numerically.

Result and Discussion

1. Result

Validity and Reliability Tests: All items in the four variables (predisposing factor, enabling factor, reinforcing factor, and Y/unsafe action variable) were declared valid because the value of r calculated (1.000) was greater than the r of the table (0.291) with a significance value of < 0.05 . All instruments were also declared reliable because Cronbach's Alpha value was above 0.60. Thus, the research instrument was appropriate and consistent to be used in data collection.

Descriptive Analysis: The study involved 46 respondents of PT XYZ employees. In the three free factors, positive responses dominated, namely 24 respondents (52.2%) stated that they agreed and 22 respondents (47.8%) stated that they strongly agreed with each item of predisposing, enabling, and reinforcing factors. In the Y variable (unsafe action), 29 respondents (63.0%) stated that they did not commit unsafe actions, while 17 respondents (37.0%) stated that they still committed unsafe actions while working.

Bivariate Analysis (Chi-Square Test): The results of the Chi-Square test showed that all items in the three free factors had a statistically significant relationship with unsafe action. The Continuity Correction value was 4.246 with a p -value of 0.039 (< 0.05) in each test, so that H_0 was rejected and H_a was accepted. This means that the predisposing factor, enabling factor, and reinforcing factor were significantly related to the occurrence of unsafe actions in PT XYZ employees, respectively.

Multivariate Analysis (Multiple Logistic Regression): After the three factors were analyzed together, the predisposing factor was the most dominant variable and had a significant effect on unsafe action, with a Wald value of 5.281 and a significance of 0.022 (< 0.05). The value of the B coefficient was -0.506 with an Odds Ratio (OR) of 0.603 and a 95% CI of 0.392–0.928. Because the $OR < 1$ and the confidence interval did not exceed 1, any increase in the predisposing factor score tended to reduce the chance of unsafe action by 0.603 times. The model equation formed was $\text{Logit}(p) = 7.404 - 0.506$ (predisposing factor).

2. Discussion

The results of the study showed that unsafe behavior in PT XYZ employees was influenced by predisposing factors, enabling factors, and reinforcing factors. These findings are in line with the PRECEDE-PROCEED (Lawrence Green) theoretical framework which states that a person's behavior is formed from the interaction of these three groups of factors. The predisposing factor has proven to be the most dominant factor. This factor includes the existence of clear occupational safety targets, good physical condition at work, and participation in OHS training. The OR value of 0.603 indicates a protective influence, namely the higher the individual's safety readiness and awareness, the less likely employees are to commit unsafe acts. This confirms that aspects of knowledge, attitude, and personal readiness are the main capital in the formation of safe work behavior.

Enabling factors, which include the availability and understanding of SOPs and feedback from superiors, are also meaningfully related to unsafe action. The availability of clear facilities and procedures makes it easier for employees to implement safe behaviors, so that this enabling factor plays a role in supporting the realization of safe work behavior. Reinforcing factors, in the form of management's activeness in work safety, the example of superiors, and the provision of rewards for safe work, are also significantly related to unsafe action. Support and strengthening of the work environment strengthens employee consistency in behaving safely. Although all three are bivariately significant, the results of the multivariate analysis confirm that predisposing factors contribute the most. Therefore, efforts to reduce unsafe actions should be prioritized on strengthening predisposing factors through routine K3 training, setting clear safety targets, and monitoring the physical condition of workers, without neglecting the strengthening of SOPs and management support.

Dominant Unsafe Action, Working Environment, and Production Pressure

Based on the results of in-depth observations in the yard area and qualitative interviews, it was found that the most dominant form of unsafe action at PT XYZ Batam City was the use of inappropriate or inconsistent personal protective equipment (PPE), as well as the act of taking shortcuts to the SOPs in rigging and lifting operations. In terms of the use of PPE, workers often remove safety glasses or face shields when grinding and welding, do not wear hearing protection in noisy areas, or relax the full body harness rope when on the work platform. Meanwhile, the SOP shortcut in rigging and lifting operations can be seen from the habit of workers ignoring pre-use inspection steps on lifting equipment, not confirming sign-off on the lift plan, or jumping from low structures to speed up the material transfer process.

The two main contextual factors that have been proven to encourage the emergence of unsafe actions are work environment factors in the form of thermal stress, as well as production pressure. The location of PT XYZ's yard on the coast of Batam has a tropical climate with very high air temperature and humidity; the use of thick protective clothing, welding masks, and tight-fitting goggles triggers heat accumulation and condensation in the protective glass, so workers impulsively remove PPE to reduce sweat and physical fatigue. On the other hand, the very strict completion target of the offshore module fabrication project creates schedule pressure; in this situation, workers are encouraged to take shortcuts to meet the daily output quota, because it takes into account that the act of ignoring small procedures will save time directly.

BBS Intervention Guide Recommendations

To address the root of the problem, a guide to unsafe action prevention interventions based on the BBS Geller model was prepared which includes three forms of intervention. Predisposed interventions respond to passive K3 knowledge and fatigue due to heat exposure through the implementation of a 10-minute daily visual Toolbox Talk, thermal stress management education, and the setting of measurable daily safety targets. Interventions may overcome the constraints of text and uncomfortable daily safety targets in hot climates through the transformation of SOPs into Visual Safe Work Instruction (SWI) in the form of illustrated posters in the work area, as well as the provision of ergonomic PPE with high air absorption. The reinforcement intervention responds to inconsistent supervisory involvement and lack of appreciation through the implementation of weekly Management Safety Walks, filling out BBS Cards between workers, and providing daily incentives or praise for workers who behave safely (Safety Champions)

Conclusion

Prevention of unsafe actions in the oil and gas fabrication industry is not enough to rely solely on rigid enforcement of technical rules, but requires the integration of a comprehensive Behavior-Based Safety (BBS) framework, because workers' unsafe behavior is formed synergistically from individual readiness (predisposing), clarity of facilities and procedures (enabling), and strengthening management commitment (reinforcing).

The unsafe action guidelines developed in this study are implemented through three levels of strategy in the field. At the operational level, management transforms rigid SOPs into visual-based Safe Work Instructions (Visual Safe Work Instruction) installed in the fabrication bay area, as well as provides ergonomic and adaptive PPE to tropical climates to reduce non-compliance due to thermal stress. At the supervisory level, the roles of supervisors and foremen are shifted from passive supervisors to active coaches through daily BBS Card-based behavior observation and constructive feedback. At the organizational level, company leaders build a non-punitive work climate and provide positive reinforcement (rewards) for safe behavior compliance to offset the pressure of production schedules. The integration of these three levels is a practical foothold to reduce the risk of near misses and build a sustainable workplace safety culture

Reference

- Andriolo, A., Ciervo, G., Gusmerotti, G., Ruspino, C., Testa, M., Bruzzi, R., & Falivene, M. R. (2023). Behavior-based safety: An effective approach to reduce unsafe acts in manufacturing plants. *Safety Science*, 161, 106076.
- Bernardini, M., et al. (2024). Implementation of behavior-based safety in the workplace: A review of conceptual and empirical literature. *Sustainability*, 16(23), 10195.
- BPJS Ketenagakerjaan. (2024). *Statistik kecelakaan kerja di Indonesia tahun 2024*. Pusat Data dan Informasi BPJS Ketenagakerjaan.
- Carra, S., Bottani, E., Vignali, G., Madonna, M., & Monica, L. (2024). [Implementation of behavior-based safety in the workplace: A review of conceptual and empirical literature](https://doi.org/10.3390/su162310195). *Sustainability*, 16(23), Article 10195. <https://doi.org/10.3390/su162310195>
- Cooper, M. D. (2021). [Toward a model of safety culture](https://doi.org/10.1016/S0925-7535(00)00035-7). *Safety Science*, 36(2), 111–136. [10.1016/S0925-7535\(00\)00035-7](https://doi.org/10.1016/S0925-7535(00)00035-7)
- Daniellou, F., & Simard, M. (2021). [Human and organizational factors of safety: State of the art](#). In *Proceedings of the International Ergonomics Association Conference* (pp. 1–12).
- Hidayat, N., & Syaifullah, M. (2022). Penerapan behavior-based safety untuk menurunkan unsafe act di industri manufaktur. *Indonesian Journal of Occupational Safety and Health*, 11(2), 145–158.
- International Labour Organization. (2022). *Global occupational safety and health initiatives: A review*. ILO SafeWork.
- Karim, A., & Nizam, H. (2021). Analisis perilaku tidak aman (unsafe act) terhadap kejadian kecelakaan kerja di sektor konstruksi. *Jurnal Keselamatan dan Kesehatan Kerja*, 3(1), 28–42.
- Kementerian Ketenagakerjaan Republik Indonesia. (2024). *Data dan statistik ketenagakerjaan tahun 2024*. Jakarta: Kemenaker RI.
- Luria, G., & Yagil, D. (2021). Safety management in organizations: Leadership, culture, and implementation. *Journal of Applied Psychology*, 91(4), 946–956.
- Majumdar, A., Manole, I., & Nalty, R. (2022). [Analysis of port accidents and calibration of Heinrich's pyramid](https://doi.org/10.1177/03611981211044447). *Transportation Research Record*, 2676(2), 692–705. <https://doi.org/10.1177/03611981211044447>
- Mohammed, F. A. (2022). Behavioral factors influencing near miss reporting: A systematic review. *Accident Analysis & Prevention*, 163, 106462.
- Mullen, J. E., & Kelloway, E. K. (2023). [Safety leadership: A longitudinal study of the influence of transformational leadership on safety outcomes](https://doi.org/10.1348/096317908X325313). *Journal of Applied Psychology*, 94(4), 965–976. <https://doi.org/10.1348/096317908X325313>
- National Institute for Occupational Safety and Health (NIOSH). (2021). *NIOSH program portfolio*. Centers for Disease Control and Prevention.
- Occupational Safety and Health Administration (OSHA). (2021). *Prevention through design: Plan for the future*. U.S. Department of Labor.
- Phoon, L. (2022). Oil and gas industry: Occupational safety and health perspectives. *International Journal of Environmental Research and Public Health*, 19(5), 2847.
- Priyadi, B., & Wijaya, I. M. (2023). Implementasi behavior-based safety di industri fabrikasi. *Jurnal Kesehatan dan Keselamatan Kerja*, 5(2), 89–105.

- Ramachandran, A., & Kumar, R. (2021). Occupational health and safety in the oil and gas industry: Current practices and future directions. *Safety and Health at Work*, 12(3), 298–310.
- SafetyCulture. (2025). *Global workplace safety statistics 2024-2025*. SafetyCulture Pty Ltd.
- Shabani, T., Jerie, S., & Shabani, T. (2024). [A comprehensive review of the Swiss cheese model in risk management](https://doi.org/10.1007/s42797-023-00091-7). *Safety in Extreme Environments*, 6, 43–57. <https://doi.org/10.1007/s42797-023-00091-7>
- Spigener, J., Lyon, G., & McSween, T. E. (2022). [Behavior-based safety 2022: Today's evidence](https://doi.org/10.1080/01608061.2022.2048943). *Journal of Organizational Behavior Management*, 42(4), 336–359. <https://doi.org/10.1080/01608061.2022.2048943>
- Sukarto, H., & Risma, E. (2021). Faktor-faktor yang mempengaruhi perilaku aman pekerja di industri konstruksi. *Jurnal Manajemen Konstruksi*, 8(3), 234–248.
- Sunarsih, S., & Kusuma, A. (2022). Behavior-based safety sebagai strategi pencegahan near miss di lingkungan kerja manufaktur. *Jurnal Ilmu Kesehatan Masyarakat*, 13(1), 76–89.
- Utama, R., & Santoso, T. (2021). Pengaruh pelatihan behavior-based safety terhadap perilaku aman pekerja di sektor konstruksi. *Jurnal Keselamatan Konstruksi*, 7(2), 112–127.
- Weever Apps. (2024). Behavioral safety in modern workplaces: Implementation and outcomes. *Work Safe International Publications*.
- Zhang, M., et al. (2023). [Digital technology enhanced situation awareness for construction safety](https://doi.org/10.1016/j.ssci.2023.106280). *Safety Science*, 2023 [10.1016/j.ssci.2023.106280](https://doi.org/10.1016/j.ssci.2023.106280)