CENDESIA (JOURNAL OF COMMUNITY SERVICE AND SUSTAINABLE DEVELOPMENT) | Vol. 1, No. 1, February 2026, pp. 44-50

Application Of Pre-Construction Risk Assessment In Hospital Renovation Projects

Desta Atha Fahreza[1*] Muhammad Thoriq[1]
[1]Civil Engineering Department, Universitas Negeri Semarang, Semarang; Indonesia
Correspondence: destaathafahreza@students.unnes.ac.id; thoriq0703@students.unnes.ac.id

ABSTRACT

Abstract: Construction activities in hospital environments carry a high level of risk because they have the potential to cause safety, environmental, and utility disturbances, as well as increase the risk of nosocomial infections for patients and medical personnel. This study aims to analyze the application of Pre-Construction Risk Assessment (PCRA) as a risk management tool in surgical inpatient building construction projects in hospital environments. The research method used was a qualitative descriptive approach with a case study, using secondary data in the form of project PCRA documents. The analysis was carried out by examining the classification of construction activities, infection risk groups, and the suitability between the risk level and the planned control measures. The results of the study show that construction activities are dominated by work with high to very high risk categories, thus requiring the application of Class III and Class IV controls, which include dust control, air quality, utilities, and occupational safety. The PCRA documents have comprehensively identified the risks and planned control measures that are relevant to the project's risk level. However, the effectiveness of control measures depends heavily on consistent implementation and supervision in the field. This study confirms that the systematic application of PCRA from the pre-construction stage plays an important role in supporting the safety of patients, medical personnel, and construction workers, as well as maintaining the continuity of hospital services during the project.

Keywords: pre-construction risk assessment, PCRA, risk management, hospital construction

Article History:
Received: 27-01-2026
Revised : 24-02-2026
Accepted: 25-02-2026
Online : 26-02-2026

This is an open access article under the CC–BY-SA license

A. BACKGROUND

Construction, renovation, and demolition activities in healthcare facilities carry a high level of risk because they are carried out in an active environment with patients who are highly susceptible to infection and disruption of medical services (Cooper et al., 2003). Various studies show that poorly managed pre-construction activities can increase the concentration of microorganisms in the air and trigger serious nosocomial infections, especially in critical care units. (Berthelot et al., 2006).

A number of empirical studies have demonstrated a direct link between hospital construction work and an increase in Aspergillus spp. infections due to dust and ventilation system malfunctions (Cooper et al., 2003). This finding confirms that the greatest risk actually arises in the early stages of a project when

risk control planning has not yet been systematically implemented (Kanamori et al., 2015).

Pre-Construction Risk Assessment (PCRA) or Infection Control Risk Assessment (ICRA) was developed as a structured approach to identify, analyze, and control construction risks from the pre-construction stage (Kanamori et al., 2015). The implementation of PCRA has proven effective in reducing the risk of air and water contamination through physical barrier planning, dust control, and critical utility system management (Scanlon et al., 2022).

From a project management perspective, literature shows that risk assessment in the early stages of construction plays an important role in preventing delays, cost overruns, and deterioration in project quality (Zavadskas et al., 2010). The success of a construction project is greatly influenced by the quality of the risk management process carried out during the planning and pre-construction phases (Rahman & Adnan, 2020).

Recent research developments emphasize that pre-construction risk assessment must consider interrelationships between risks in order to produce more realistic analysis results and support accurate decision-making (Zhu et al., 2022). This approach is relevant for complex construction projects because risks do not exist in isolation, but rather influence each other from the early stages of the project (Zhu et al., 2022).

In addition to managerial aspects, technical control of buildings such as ventilation and air pressure systems are also an important part of PCRA in healthcare facilities (Chow et al., 2006). The integration of PCRA with technical planning, occupational safety, and project sustainability from the pre-construction stage is considered important to ensure patient safety and the continuity of hospital services during the project (Junjia et al., 2023).

B. IMPLEMENTATION METHODS

This study uses a qualitative descriptive approach with a case study method to analyze the application of construction risk management in the construction project of a surgical inpatient building in a hospital environment. This approach was chosen because the study aims to describe in depth the actual conditions of construction risks and control efforts based on the official Pre-Construction Risk Assessment (PCRA) document.

The research location is in the area of the former HD, HCU, and Blood Bank buildings, with a project duration of 30 calendar days. The research subjects include all construction activities listed in the PCRA document, particularly demolition, renovation, and new construction work that has the potential to

cause occupational safety risks, environmental disturbances, utility failures, and infection risks to patients and medical personnel.

The data used is secondary data sourced from the project's PCRA documents. This data includes information on project characteristics, identification of physical and environmental risks, potential impacts on surrounding areas, utility system disruptions, and air quality control and infection prevention. In addition, data on construction activity classification (Type A–D), infection risk groups (Group 1–4), and risk control provisions (Class I–IV) were also analyzed as a basis for evaluating the implementation of construction risk management.

Data collection techniques were carried out through documentation studies, by systematically reviewing all parts of the PCRA document. This process aimed to identify the types of construction activities, affected areas, potential risks that arose, and risk control plans that were implemented before, during, and after the construction project.

Data analysis was conducted using descriptive qualitative methods in several stages. The first stage involved grouping construction activities based on dust production levels and work complexity. The second stage was the determination of infection risk groups according to the characteristics of the affected hospital areas. The third stage was an analysis of the suitability between the level of risk and the planned control measures, including dust, noise, vibration, and utility control, as well as the implementation of occupational safety and health. The final stage was an evaluation of the adequacy of risk mitigation measures for the safety of patients, medical personnel, and construction workers.

The results of the analysis are presented in descriptive form to provide a comprehensive overview of the effectiveness of the implementation of construction risk management and infection prevention in the construction project of a surgical inpatient building in a hospital environment.

C. RESULT AND DISCUSSION

1. Identification and Classification of Construction Risks

   Based on the analysis of the Pre-Construction Risk Assessment (PCRA) document, the surgical inpatient building construction project has a high level of complexity and risk because it is carried out in an active hospital environment and is adjacent to critical service areas. The planned construction activities include demolition, new construction, and utility work that has the potential to generate dust, noise, vibrations, and disruption to the hospital support systems.

   To clarify the results of risk identification and classification, a summary of the analysis results is presented in Table 1.

Table 1. Summary of Construction Risk Identification and Classification Results

Aspects Analyzed	Identification Results
Dominant activity type	Demolition of floors and walls, new construction, utility work
Classification of construction activities	Type C dan Type D
Primary sources of risk	Dust, noise, vibration, utility disturbances
Affected area	Emergency Room, Intensive Care Unit, Radiotherapy, inpatient area
Infection risk group	Group 3 (high) – Group 4 (very high)
Risk management class	Class III and Class IV
Primary control	Critical barrier, negative air pressure, HEPA filter, ILSM

Table 1 shows that project activities are dominated by work with moderate to high dust production levels and long work durations, placing the project in the high to very high risk category. These conditions confirm that the implementation of layered risk control is a key requirement in project execution.

2. Discussion of Physical, Environmental, and Utility Risks

The most prominent physical risks in this project are noise and vibration, which have the potential to disrupt medical services in the surrounding units. Control measures in the form of closing room openings, regulating work methods, and controlling the use of heavy equipment demonstrate the appropriateness of the risk level and mitigation plan outlined in the PCRA document.

From an environmental and utility perspective, the analysis results indicate potential disruptions to the electrical, HVAC, clean water, medical gas, and fire protection systems. The PCRA document has anticipated these risks through the implementation of emergency procedures, notification to affected units, and readiness to implement Interim Life Safety Measures (ILSM). This shows that the continuity of hospital services has been a primary consideration in project planning.

3. Discussion on Air Quality Control and Infection Prevention

Construction dust is the dominant risk that most significantly affects patient safety, especially in areas with high vulnerability. The classification results show that the majority of activities require the implementation of Class III and Class IV controls, which include the installation of critical barriers, control of worker access, the application of negative air pressure, and the use of HEPA filtration units.

This control plays an important role in preventing the spread of dust particles and microorganisms to patient care areas. Thus, the alignment between infection risk classification and planned control measures indicates that the infection prevention approach has been systematically designed according to the project's risk level.

4. Synthesis of Results and Implications

Overall, the research results summarized in the table and discussion show that the PCRA document has been able to comprehensively identify construction risks and establish control measures relevant to the level of risk faced. The integration of occupational safety, environmental, utility, and infection prevention aspects reflects the readiness of project risk management in supporting patient safety and the continuity of hospital services during the construction period.

D. CONCLUSION AND RECOMMENDATIONS

Based on the results of the Pre-Construction Risk Assessment (PCRA) document analysis, it can be concluded that the surgical inpatient building construction project has a high to very high level of construction risk because it is carried out in an active hospital environment and is adjacent to critical service areas. Construction activities are dominated by demolition and large-scale construction work that generates dust, noise, vibrations, and has the potential to cause utility disruptions and infection risks.

The classification results show that most activities fall under Type C and Type D with infection risk groups 3 and 4, thus requiring the implementation of Class III and Class IV risk controls. The PCRA document has comprehensively identified risks and planned control measures covering occupational safety, environmental control, air quality, and infection prevention. This indicates that the project risk management plan has been systematically developed and is aligned with the level of risk faced.

Based on the results of the Pre-Construction Risk Assessment (PCRA) document analysis, the surgical inpatient building construction project has a high to very high level of construction risk because it is carried out in an active hospital environment and is adjacent to critical service areas, thus requiring the consistent application of Class III and Class IV risk controls. The PCRA document has comprehensively identified physical, environmental, utility, and infection risks, but its effectiveness is highly dependent on implementation and supervision in the field. Therefore, periodic monitoring and ongoing coordination between contractors, project management, and the K3RS and PPI teams are necessary to ensure the safety of patients, medical personnel, and construction workers, as well as to maintain the continuity of hospital services during the project.

ACKNOWLEDGEMENTS

The authors would like to express their sincere gratitude to Muhammad Faizal Ardhiansyah Arifin, S.T., M.T., Ph.D. for his valuable guidance, constructive feedback, and continuous academic support throughout the preparation of this paper. The authors also gratefully acknowledge Universitas Negeri Semarang for providing academic facilities and access to scientific databases and journal repositories used in this literature review. Finally, appreciation is extended to all colleagues and individuals who contributed directly or indirectly to the successful completion of this study.

REFERENCES

Berthelot, P., Loulergue, P., Raberin, H., Turco, M., Mounier, C., Tran Manh Sung, R., Lucht, F., Pozzetto, B., & Guyotat, D. (2006). Efficacy of environmental measures to decrease the risk of hospital-acquired aspergillosis in patients hospitalised in haematology wards. *Clinical Microbiology and Infection*, *12*(8), 738–744. https://doi.org/10.1111/j.1469-0691.2006.01499.x

Chow, T. T., Kwan, A., Lin, Z., & Bai, W. (2006). Conversion of operating theatre from positive to negative pressure environment. *Journal of Hospital Infection*, *64*(4), 371–378. https://doi.org/10.1016/j.jhin.2006.07.020

Cooper, E. E., O'Reilly, M. A., Guest, D. I., & Dharmage, S. C. (2003). Influence of Building Construction Work On Aspergillus Infection in a Hospital Setting . *Infection Control & Hospital Epidemiology*, *24*(7), 472–476. https://doi.org/10.1086/502239

Junjia, Y., Alias, A. H., Haron, N. A., & Abu Bakar, N. (2023). A Bibliometric Review on Safety Risk Assessment of Construction Based on CiteSpace Software and WoS Database. In *Sustainability (Switzerland)* (Vol. 15, Number 15). Multidisciplinary Digital Publishing Institute (MDPI). https://doi.org/10.3390/su151511803

Kanamori, H., Rutala, W. A., Sickbert-Bennett, E. E., & Weber, D. J. (2015). Review of Fungal Outbreaks and Infection Prevention in Healthcare Settings during Construction and Renovation. *Clinical Infectious Diseases*, *61*(3), 433–444. https://doi.org/10.1093/cid/civ297

Rahman, M. S., & Adnan, T. M. (2020). Risk management and risk management performance measurement in the construction projects of Finland. *Journal of Project Management (Canada)*, *5*(3), 167–178. https://doi.org/10.5267/j.jpm.2020.5.001

Scanlon, M. M., Gordon, J. L., Tonozzi, A. A., & Griffin, S. C. (2022). Reducing the Risk of Healthcare Associated Infections from Legionella and Other Waterborne Pathogens Using a Water Management for Construction (WMC) Infection Control Risk Assessment (ICRA) Tool. *Infectious Disease Reports*, *14*(3), 341–359. https://doi.org/10.3390/idr14030039

Zavadskas, E. K., Turskis, Z., & Tamošaitiene, J. (2010). Risk assessment of construction projects. *Journal of Civil Engineering and Management*, *16*(1), 33–46. https://doi.org/10.3846/jcem.2010.03

Zhu, F., Hu, H., & Xu, F. (2022). Risk assessment model for international construction projects considering risk interdependence using the DEMATEL method. *PLoS ONE, 17*(5 May). https://doi.org/10.1371/journal.pone.0265972