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A Study on the Relationship between On-site Management Personnel Turnover and Accident Rate in Construction Enterprises

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Abstract: *The stability of on-site management personnel has a significant impact on safe production, but its effect has long lacked systematic quantitative research. This study conducts an empirical analysis on the relationship between on-site management personnel turnover and accident rate. The study uses project data from a construction enterprise over 36 consecutive months, covering 92 construction projects, 1,740 on-site management personnel, and 286 accident records. Personnel turnover is measured by the number of management personnel changes within the project cycle, and safety performance is represented by accident rate and severity grading indicators. A negative binomial regression model is used to analyze the impact of personnel turnover on accident frequency. The results show that projects with frequent management personnel changes have significantly higher accident rates than projects with stable personnel. This study provides a quantitative basis for construction enterprises to strengthen the stability of on-site management personnel.*

Keywords: *Construction; Personnel turnover; Accident; Negative binomial regression; Safety management*

1.Introduction

Construction activities are consistently associated with elevated safety risk due to dynamic site conditions, overlapping operations, subcontractor interactions, and strict schedule constraints. Although regulatory frameworks and technical control measures have improved in recent years, accident rates in construction remain higher than in most other industries [1,2]. This persistent gap has prompted growing attention toward organizational and management-related determinants of project-level safety performance. Prior research indicates that supervision intensity, coordination mechanisms, and the continuity of safety enforcement substantially influence daily safety

outcomes on site [3,4]. Evidence from broader organizational studies further suggests that strategic human resource configuration and data-driven leadership practices shape operational reliability and risk control in complex, knowledge-intensive environments [5]. These findings imply that management staffing stability and supervisory continuity may constitute structural drivers of safety performance rather than merely contextual factors. A substantial body of literature has examined the role of leadership and supervision in construction safety. Empirical studies demonstrate that supervisors are central in translating formal safety policies into daily work practices and in responding to emerging hazards [6]. Clear communication of safety expectations and consistent monitoring are associated with higher compliance levels and fewer unsafe behaviors [7]. Research on safety climate also shows that workers' perceptions of management commitment and organizational support are significantly associated with accident occurrence and reporting patterns [8,9]. However, most of this evidence is derived from cross-sectional survey data, capturing perceptions at a single time point and overlooking temporal variation in management presence and supervisory consistency throughout project execution. Personnel turnover has long been recognized as a structural challenge in construction, yet its safety implications are often explored indirectly. Many studies focus on turnover intention rather than observed managerial changes on site [10]. Research on retention commonly links turnover intention to job stress, perceived organizational support, and training conditions [11,12]. While these findings enhance understanding of workforce stability, intention-based measures do not necessarily correspond to actual replacement of site management personnel. In practice, frequent turnover among on-site managers may interrupt established supervision routines, reduce familiarity with site-specific hazards, and weaken the continuity of safety enforcement, especially during technically complex or high-risk construction phases. Such disruptions may alter communication channels, delay hazard response, and diminish the effectiveness of established safety control systems. Methodological constraints further limit existing evidence. Safety incidents are typically recorded as count data and frequently exhibit over-dispersion; negative binomial regression is widely regarded as an appropriate analytical method under such distributional conditions [13]. Recent database-driven studies confirm that accident frequency and severity respond differently to managerial practices and compliance mechanisms [14,15]. Despite methodological advances, many empirical analyses implicitly assume stable project teams during the observation period and do not account for within-project management changes. In addition, safety research often relies on limited samples, single projects, or short monitoring intervals, reducing its relevance for large construction enterprises operating multiple projects under unified safety governance systems [16]. Another limitation lies in the limited integration of human resource dynamics into safety performance models. While organizational research emphasizes the role of leadership continuity and structured human resource management in sustaining operational outcomes [17], construction safety studies seldom quantify how observable managerial turnover affects accident occurrence over time. Without longitudinal operational data, it remains difficult to determine whether management instability has a measurable association with incident frequency and severity, or whether its effects vary across project duration and risk exposure levels. Addressing this gap is essential for enterprises seeking to align staffing policies with safety performance objectives [18]. Against this background, the present study investigates the relationship between on-site management staff turnover and safety accident occurrence using longitudinal project-level data from a large construction enterprise. The dataset spans 36 consecutive months and includes 92 construction projects, 1,740 site management personnel records, and 286 documented safety accidents. Management turnover is operationalized as the number of personnel changes during each project cycle, capturing observable staffing instability rather than intention-based measures. Safety performance is assessed using both accident frequency and severity-based indicators to

reflect multidimensional risk outcomes. A negative binomial regression framework is employed to model the association between management stability and accident occurrence while accounting for the statistical properties of count data. By relying on continuous operational records rather than perception-based surveys, this study provides quantitative evidence on the safety implications of managerial continuity. The findings contribute to a more precise understanding of how staffing stability interacts with risk control mechanisms and offer empirical guidance for staffing strategy and safety policy formulation in construction enterprises managing multiple concurrent projects.

2.Materials And Methods

2.1 Sample And Study Context

The study is based on internal records from a building construction enterprise operating under a unified safety management framework. Data were collected over a continuous 36-month period and cover 92 construction projects carried out at different sites. The sample includes 1,740 on-site management personnel, such as project managers, site engineers, safety supervisors, and foremen. During the same period, 286 safety accidents were officially documented. Only projects with complete personnel and accident records were included. The analysis focuses on active construction stages, where on-site management staff are continuously present and directly involved in safety supervision.

2.2 Study Design and Comparison Framework

A comparative observational design was used to assess differences in safety outcomes under varying levels of management staff stability. Projects were grouped according to the number of on-site management personnel changes during the project period. Projects with fewer personnel changes were defined as the stable-management group, while projects with more frequent changes formed the comparison group. This grouping is supported by safety management theory, which emphasizes the importance of supervisory continuity and accumulated site knowledge for effective hazard control. All projects followed the same corporate safety rules, which limits variation caused by company-level policies.

2.3 Measurement and Quality Control

Management staff turnover was measured as the total count of personnel replacements in on-site management positions during each project. Safety performance was measured using recorded accident counts and a severity classification based on the enterprise safety reporting system. Accident records were obtained from official incident reports and checked against safety department databases. Personnel change information was verified using human resource records and project staffing logs. Data consistency checks were conducted across all sources, and projects with missing or inconsistent information were removed before analysis.

2.4 Data Processing and Model Specification

Accident data were analyzed as count variables and tested for over-dispersion. Because the variance exceeded the mean, a negative binomial regression model was selected. The expected accident count for project iii is defined as

$$E(Y_i)=\mu_i, \quad \ln(\mu_i)=\beta_0+\beta_1 T_i+\beta_2 X_i,$$

where Y_i denotes the number of accidents, T_i represents management staff turnover, and X_i includes control variables such as project duration and scale. In addition, an accident rate indicator was calculated as

$$R_i=\frac{Y_i}{D_i},$$

where D_i represents the project exposure time in months. Variables were scaled where necessary to allow comparison across projects.

2.5 Statistical Analysis

Model estimation was conducted using maximum likelihood methods with robust standard errors. The dispersion parameter was examined to confirm the suitability of the negative binomial model. Model fit was assessed using likelihood-based statistics and residual checks. Sensitivity tests were performed by excluding projects with very high accident counts and by adjusting exposure definitions. Statistical significance was evaluated using standard confidence levels, and all analyses were carried out using widely used statistical software to support reproducibility.

3.Results And Discussion

3.1 Accident frequency pattern and turnover clustering

Accident records from the 92 projects display a highly uneven distribution. Most projects experienced no accidents or only a small number, whereas a limited subset accounted for a large proportion of the 286 recorded events. Such concentration is widely observed in construction safety data and indicates substantial variation in risk across projects. Projects with frequent on-site management replacements appeared more often among those with higher accident counts, suggesting that management continuity is related to routine hazard control. Similar concentration patterns in accident types and severity levels have been reported in recent construction safety datasets, where a small number of accident pathways contribute disproportionately to overall harm [19,20].

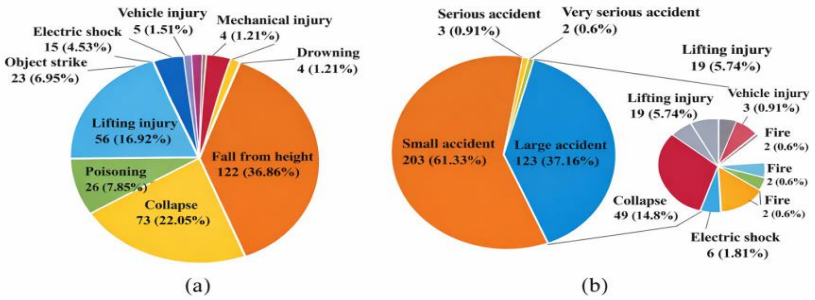

Fig.1.*Distribution of construction accidents by type and severity, highlighting the concentration of incidents in a small number of categories.*

3.2 Negative binomial results and dispersion-based interpretation

Results from the negative binomial regression indicate a clear positive relationship between management turnover and accident frequency after controlling for project exposure and basic project characteristics. The direction of this relationship is consistent with the descriptive findings: projects with repeated management changes tend to show higher expected accident counts than projects with stable management teams [21]. The dispersion parameter is statistically meaningful, confirming that accident variance across projects exceeds the level assumed by a Poisson model. This supports the selected modeling approach and avoids underestimation of statistical uncertainty. From an operational perspective, the results indicate that each additional management replacement is associated with a higher expected number of accidents, with the effect becoming more apparent in projects operating under higher-risk conditions, such as intensive subcontracting or overlapping activities, where daily supervision continuity is critical.

3.3 Comparison with prior studies and on-site mechanisms

Previous construction safety research often explains accident differences through safety leadership, safety climate, training coverage, and rule enforcement. However, many studies treat the management team as unchanged during project execution or rely on cross-sectional survey data. The present project-level analysis demonstrates that actual management replacement within projects is measurably related to accident frequency. A practical explanation aligns with site operations: personnel changes can weaken routine hazard inspections, disrupt follow-up on unresolved safety issues, and reduce familiarity with site-specific risks and subcontractor practices. These effects are especially pronounced for hazards that require continuous coordination rather than one-time correction. This interpretation is consistent with systems-based safety research that emphasizes stable responsibility structures, continuous information flow, and closed feedback loops between hazard identification and corrective action [22,23].

3.4 Implications for staffing policy and study limitations

The findings support staffing strategies that prioritize continuity in key on-site management roles, particularly safety supervisors and coordination-intensive positions. When personnel rotation cannot be avoided, risk reduction should focus on improving handover quality rather than formal completion alone. Short overlap periods, standardized handover checklists, and a clearly assigned register of open safety issues with documented closure can reduce gaps created by management changes. At the same time, the results should be interpreted within the study scope. The dataset is drawn from a single enterprise, and unobserved factors such as construction phase intensity, subcontractor composition, or task complexity may influence both management turnover and accident exposure. Future research could improve inference by distinguishing turnover by role type, incorporating phase-specific exposure measures, and extending the analysis to multiple firms. A further research direction is to link management turnover with leading safety indicators, such as near-miss reporting and inspection closure rates, in line with recent work on digital safety monitoring and feedback systems across the project lifecycle [24]. Fig.2. Theoretical framework for lifecycle-oriented safety information integration.

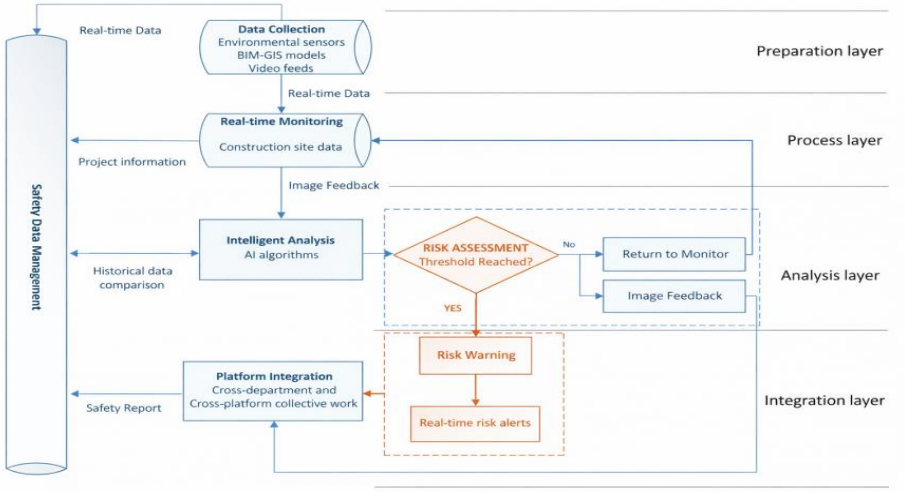

Fig.2.*Conceptual framework showing how safety information is linked across project stages to support continuous risk control.*

5.Conclusion

This study examined the association between on-site management staff turnover and safety accident occurrence in construction projects using longitudinal enterprise data. The results indicate that projects with frequent management changes tend to experience higher accident rates than

projects with stable management teams, even after controlling for exposure time and basic project characteristics. The negative binomial analysis confirms that management turnover is closely related to accident frequency in settings where safety outcomes differ markedly across projects. These findings suggest that stable on-site management supports continuous hazard identification and timely corrective action.The main contribution of this study is the use of observed within-project management changes, rather than perception-based indicators, to quantify their relationship with construction safety outcomes. This provides empirical evidence that complements existing research focused on leadership style, safety climate, and training practices. From an application perspective, the results support staffing strategies that maintain continuity in key site management roles and strengthen handover procedures when personnel changes are unavoidable. Several limitations remain. The analysis relies on data from a single enterprise, and factors such as project complexity, subcontractor involvement, and construction phase intensity were not fully captured. Future studies may extend this work by using multi-firm datasets, distinguishing turnover by management role, and incorporating leading safety indicators to further clarify how management stability affects construction safety performance.

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