



RM and Reengineering Strategies for Mitigating the Effects of Night Work on Productivity and Workforce Well-being in Industrialized Construction Projects

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OPEN ACCESS

Article type: Research Article

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Received: September 16, 2025

Accepted: October 13, 2025

Published: Autumn 2025

Citation: Zarei Mahmoud abadi, M. & Beheshtifard, M. (2025). RM and Reengineering Strategies for Mitigating the Effects of Night Work on Productivity and Workforce Well-being in Industrialized Construction Projects. *Strategic Management Accounting*, 2(3),25-48.

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Abstract

Night shifts are an unavoidable necessity in tunnel form construction projects due to technical requirements. This study aims to investigate the impact of these shifts on workers' mental and physical health and to propose engineering interventions to mitigate these effects. This research employed a mixed-method (qualitative-quantitative) approach. The statistical population consisted of 100 workers engaged in tunnel form projects, selected through random sampling. Data were collected using standardized questionnaires, including the General Health Questionnaire (GHQ-28), the Pittsburgh Sleep Quality Index (PSQI), and a Job Stress Questionnaire. Data analysis revealed that night work was associated with significant negative consequences, including a marked reduction in sleep quality ($p < 0.05$), increased job stress levels, and diminished workplace safety. Furthermore, the implementation of reengineering solutions—such as replacing metal forms with lightweight, abrasion-resistant polymeric forms, scheduling high-noise activities for permissible hours, and optimizing shift schedules—resulted in a considerable improvement in worker health indicators and a simultaneous increase in project operational efficiency. The findings underscore the necessity of revising executive process management and implementing engineering modifications to reduce the adverse effects of night work. The strategies proposed in this study are applicable within the construction industry and can be integrated into comprehensive Health, Safety, and Environment (HSE) programs.

Keywords: Night Work, Mental Health, Job Stress, Sleep Quality, Industrialized Construction, Tunnel Formwork, Process Reengineering, Occupational Safety.

JEL Classification:

DOI: [10.22034/smajournal.2025.547505.1143](https://doi.org/10.22034/smajournal.2025.547505.1143)

INTRODUCTION

The tunnel formwork system, a modern method of industrialized construction, offers significant advantages in speed, cost-effectiveness, and structural integrity. However, its technical prerequisite for a continuous 24-hour concrete pouring cycle makes night shifts an unavoidable necessity. This presents a critical challenge to the occupational health and safety (OHS) landscape of the construction industry, which already accounts for a disproportionate number of workplace accidents. While the technical efficiency of tunnel formwork is well-documented, research has largely overlooked the profound physiological and psychological toll that sustained night work exacts on the workforce. This study addresses this gap by investigating the multifaceted impacts of night work on workers' mental and physical well-being and proposes an integrated framework of Human Resource Management (HRM) and process reengineering strategies to mitigate these adverse effects, thereby enhancing both workforce welfare and project productivity.

METHODOLOGY

This research employed a sequential mixed-methods approach (qualitative-quantitative) to ensure a comprehensive understanding of the phenomenon. The statistical population consisted of workers with at least six months of night shift experience in tunnel form projects. The qualitative phase involved semi-structured interviews with 30 workers, and the data were analyzed using the Grounded Theory (GT) method, proceeding through open, axial, and selective coding stages. This identified seven core categories of challenges. The quantitative phase utilized a larger sample of 384 workers, selected via Cochran's formula. Data were collected using standardized instruments, including the General Health Questionnaire (GHQ-28), the Pittsburgh Sleep Quality Index (PSQI), and a Job Stress Questionnaire. The quantitative data were analyzed using SPSS software, employing regression analysis to test the relationships between the identified factors and workers' health.

RESULTS

The integrated analysis yielded compelling evidence of the detrimental effects of night work. The qualitative GT analysis identified seven primary factors negatively impacting workers: sleep cycle disruption, job stress, physical fatigue, reduced safety, familial problems, decreased productivity, and disruptive noise. The subsequent quantitative analysis robustly confirmed these findings, demonstrating that all seven factors had a statistically significant ($p < 0.01$) and substantial impact on workers' physical and mental health. Key regression coefficients included Sleep Disruption ($\beta = 0.52$), Job Stress ($\beta = 0.60$), Physical Fatigue ($\beta = 0.56$), and Reduced Safety ($\beta = 0.61$). The study further established that the proposed reengineering interventions—such as replacing heavy metal forms with lightweight polymer forms, optimizing shift schedules to reduce consecutive night shifts, improving site lighting, and using silent, lockable formwork systems—are directly targeted at these root causes and are perceived as viable solutions to significantly improve health indicators and simultaneously enhance project operational efficiency.

CONCLUSION

This study conclusively demonstrates that night work in tunnel form construction projects poses a severe and multi-dimensional threat to workforce well-being, which in turn undermines productivity and safety. The findings underscore the critical necessity of moving beyond traditional management approaches. The proposed integration of HRM strategies (e.g., better shift rotation, psychological support) with technical process reengineering (e.g., material and process innovation) offers a holistic and actionable framework. This framework is not merely a cost but a strategic investment into human capital. Its implementation is essential for the sustainable development of the construction industry, leading to a healthier workforce, a significant reduction in accidents, and enhanced project outcomes. The strategies outlined are directly applicable and should be integrated into comprehensive Health, Safety, and Environment (HSE) programs to foster a culture of self-care and safety in the workplace.

Contribution of Authors

The authors jointly contribute to the preparation and publication of the article.

Ethical Approval

Informed written consent was obtained from individuals for the publication of their anonymous information in this study.

Sponsor

This study had no sponsor.

Conflict of Interest

No conflict of interest was declared by the authors.

Acknowledgements

The authors sincerely thank all the construction workers and project staff who participated in this study, whose insights were invaluable. We also extend our gratitude to the site managers and HSE officers for facilitating the research.

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