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Option 2

Establishment of High-risk Management Standards for NATM Tunnels by Combining the ALARP Method and SML

Batagalle Vinuri Gimanthika KARUNARATHNE 1* Dong il KIM** Nam Ju PARK*** Byung Soo KIM****

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1. INTRODUCTION

Tunnel projects are complex, high-risk constructions with challenges from geology, safety, and methods that are more demanding than other infrastructure projects. So effectively managing high risks in tunnels is of utmost importance. Our primary objective of this research is to identify high-risk that can be mitigated cost-effectively in NATM (New Austrian Tunnelling Method) tunnel projects according to site conditions. This research introduces a novel approach by employing the SML method while also pioneering the application of ALARP (As Low As Reasonably Practicable) and SML (Security Market Line) methodologies for risk management in NATM tunnel projects.

2. HIGH-RISK MANAGEMENT IN NATM TUNNEL PROJECTS

In our preceding research, we developed a comprehensive risk database tailored to NATM tunnel projects, systematically categorising risks based on site conditions and a defined risk index. Despite this categorization, a standardised threshold for risk management within these projects remains to be established. In this study, we are awakened to fill that gap. So in this study, we used the ALARP method and SML to identify high-risk risks that can be mitigated cost-effectively in NATM tunnel projects. While previous research has utilized the ALARP method to assess risks in construction and investment contexts (Maselli, 2021), there has been no exploration of its application specifically to tunnel risks. Therefore, we propose a new approach suitable for identifying major risks that can be cost-effectively managed in NATM tunnel projects. A large imbalance will be shown if the costs of the risk treatment are much greater than the benefits (Mare, 2018). So using the ALARP method, we used cost-effectiveness as the standard to catogorize intolerable high risks. The SML is used to determine whether an investment to mitigate NATM tunnel risks provides a favorable expected return relative to its level of risk (Kenton, 2022). Initially, high-risk index entities that are based on site condition were extracted from the database, followed by an assessment to classify these into broadly acceptable, ALARP, and unacceptable risks using the ALARP framework, which defines acceptability and tolerability thresholds. Risks are deemed: (a) acceptable if below the threshold, allowing for feasible intervention; (b) too high if above the tolerability limit, advising against investment; or (c) tolerable within the ALARP principle for intermediate risks (Mare, 2018). In the next step, the ERR (Expected Rate of Return) on an investment is calculated using SML for the risks in the categories in (b) and (c). The SML is a visual representation derived from the CAPM (Capital Asset Pricing Model) that delineates the relationship between the expected return of a security or portfolio and its systematic risk, measured by beta. On the graph, where the y-axis represents the expected return and the x-axis shows the beta, securities plotted above the SML are deemed undervalued, offering higher returns for their risk level. Conversely, those below the SML are seen as overvalued, yielding lower returns for the risk incurred (Kenton, 2022). Finally, by using the graph, high-risk areas are identified that can be effectively mitigated in NATM tunnel projects.

3. CONCLUTION

This research presents a novel approach to risk management in NATM tunnel projects by combining ALARP and SML methodologies. It utilizes an existing risk database to categorize risks and employs the ALARP principle for cost-effective risk mitigation, alongside the SML method to assess the expected returns of risk mitigation investments. The study identifies economically viable strategies for managing high risks in tunnel projects, bridging a gap in current practices, and highlighting the synergy between financial and engineering approaches to enhance project safety and efficiency.

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