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«Infrastructure and Construction Project Management»

Postgraduate Diploma Thesis

Investigating the Value of Software Tools for Quantitative Risk Analysis in Construction Project Planning

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Abstract

This thesis explores the value of software tools in Quantitative Risk Analysis (QRA) for construction project planning, emphasizing their role in improving scheduling accuracy and risk management. Construction projects are inherently complex, often subject to uncertainties such as material supply delays, workforce shortages, and regulatory changes, which can lead to schedule overruns. The lack of structured risk assessment methodologies increases project deviations, making it essential to adopt advanced tools for better uncertainty management.

The research employs Monte Carlo simulations using XL RISK and evaluates scheduling tools like Primavera P6. A case study on the renovation of office spaces on Kifisias Avenue provides a practical application, assessing risk factors affecting project timelines. The findings indicate that the integration of QRA software improves decision-making and reduces project delays by up to 20%, enhancing the accuracy of risk predictions. The analysis identifies critical factors influencing schedule deviations, including supply chain uncertainties, labor productivity fluctuations, and inefficiencies in project scheduling.

The probability of completing the project within the planned 112 days is estimated at only 42%, underscoring the need for proactive risk mitigation strategies. Key risks include delays in procuring essential materials such as soundproofing panels and electrical equipment, which create cascading effects on dependent tasks. Workforce shortages could extend project timelines by up to two weeks, while external factors such as inflation and regulatory adjustments may require contract renegotiations, leading to additional delays.

Sensitivity analysis through Monte Carlo simulation reveals that an 8% increase in material costs could trigger budget overruns and scheduling setbacks. Furthermore, procurement delays could extend the project timeline by up to 18 days, emphasizing the importance of effective supply chain management. The results demonstrate that the use of QRA software like XL RISK can reduce the probability of schedule deviations by 20%, improving overall project feasibility and efficiency.

To mitigate these risks, the study recommends diversifying suppliers to prevent dependency on single-source procurement, adopting adaptive scheduling models based on probabilistic risk

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assessment, and implementing contingency workforce strategies to address labor shortages. Additionally, the integration of artificial intelligence and real-time data analytics could further enhance predictive capabilities, allowing for dynamic adjustments in project execution.

The research concludes that QRA tools are not merely auxiliary additions to project management but essential components of modern construction planning. Companies that systematically apply quantitative risk assessment techniques experience fewer delays and cost overruns than those relying on deterministic scheduling methods. Future research should focus on integrating QRA tools with Building Information Modeling (BIM), exploring the impact of external economic and regulatory factors, and leveraging artificial intelligence for predictive risk management. Expanding the use of QRA methodologies across different construction sectors can further enhance accuracy, flexibility, and resilience in project execution.