

ANALYSIS OF PROJECT DELAYS FROM A HUMAN RESOURCE MANAGEMENT PERSPECTIVE USING FAULT TREE ANALYSIS (FTA) IN A HOSPITAL CONSTRUCTION PROJECT

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Abstract

Project delays remain a critical issue in construction projects, particularly in hospital developments that involve high complexity, strict functional requirements, and intensive coordination among multidisciplinary teams. Empirical evidence indicates that many delays are not solely caused by technical or material factors, but are strongly associated with deficiencies in human resource management (HRM). This study addresses the question of how human resource-related factors structurally contribute to project delays and what root causes dominate these delays in hospital construction projects. To answer this question, the research applies Fault Tree Analysis (FTA) as the primary analytical method, using a deductive and top-down approach to decompose the main delay event into intermediate and basic events related to HRM practices. A case study was conducted on a hospital construction project in Jakarta that experienced significant schedule deviation. Data were collected through questionnaires, interviews with project personnel, and project documentation, and subsequently modeled into a fault tree structure using logical AND and OR relationships. The results indicate that ineffective workforce planning and weak coordination and communication systems constitute the most critical root causes of project delays. These factors trigger cascading effects such as work interruptions, rework, low labor productivity, and delayed decision-making, which collectively lead to schedule overruns. This study contributes academically by demonstrating the applicability of FTA as a structured root-cause analysis tool for project delays from a human resource management perspective, thereby extending delay analysis literature beyond conventional technical and descriptive approaches, particularly in the context of hospital construction projects.

Keywords: *Project Delay, Fault Tree Analysis (FTA), Human Resource Management, Root Cause Analysis, Hospital Construction Project*

INTRODUCTION

Hospital construction projects are inherently complex due to stringent quality requirements, specialized functional spaces, and the involvement of multiple interdisciplinary stakeholders. These characteristics increase the vulnerability of hospital projects to schedule delays, particularly when project resources—most notably human resources—are not managed effectively. In practice, project delays are not solely attributable to technical or material-related issues; rather, they are significantly influenced by deficiencies in workforce planning, inadequate team coordination, and ineffective site supervision. Various risk analysis methods have been employed to investigate the causes of construction project delays, one of which is Fault Tree Analysis (FTA). FTA is a deductive, logic-based analytical technique that identifies the root causes of system failures by modeling cause-effect relationships through AND and OR logic gates. Using a top-down approach, FTA provides a structured and systematic representation of how basic events interact to produce a major failure event. This study applies Fault Tree Analysis to examine project delays from a human resource management perspective in a hospital construction project. The primary objective is to map the structural relationships among human resource-related delay factors and to identify the most critical root causes contributing to project schedule overruns.

METHOD

This study employs an original empirical research design with a qualitative-analytical approach supported by structured logical modeling. The research is conducted as a case study focusing on a hospital construction

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project that experienced significant schedule delays. The primary objective of the methodology is to identify and structurally analyze the root causes of project delays from a human resource management perspective. Data sources consist of both primary and secondary data. Primary data were obtained through questionnaires and semi-structured interviews with project stakeholders, including project managers, site engineers, supervisors, and field personnel who were directly involved in project execution. Secondary data were collected from project documents such as work schedules, progress reports, organizational structures, and internal delay records. These data sources were used to ensure triangulation and improve the reliability of the analysis.

The analysis method applied in this study is Fault Tree Analysis (FTA). The analytical process begins by defining the top event, namely project delay, followed by the identification of intermediate events and basic events related to human resource management issues. Logical relationships among events are modeled using AND and OR gates to construct a fault tree diagram. This structure enables a systematic examination of causal pathways and the identification of critical root causes contributing to delays. With regard to sharia issues, this research does not directly address normative sharia compliance, as the object of analysis is a conventional construction project. However, the analytical mechanism applied—FTA—ensures ethical neutrality, transparency, and accountability in identifying human resource-related risks, which aligns with general sharia principles of responsibility, fairness, and prevention of harm (mafsadah). Thus, while sharia aspects are not examined substantively, the methodological framework remains compatible with ethical and governance-based analytical standards.

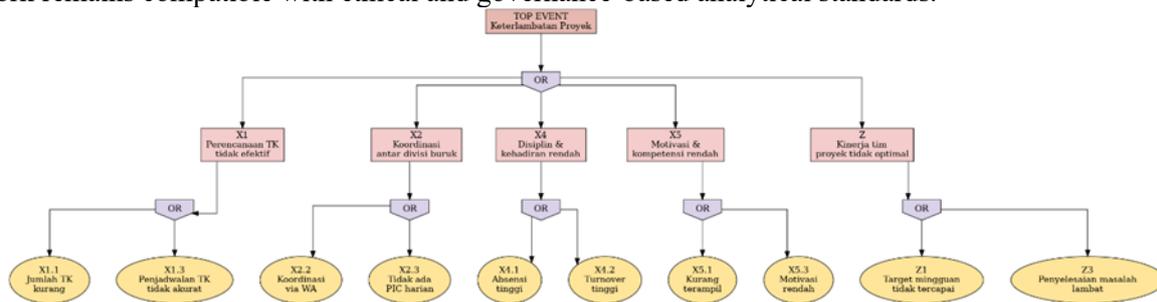


Figure 1. Fault Tree Diagram of Project Delay in Hospital Construction Project

RESULTS AND DISCUSSION

Results

This study aims to identify the root causes of project delays in hospital construction projects from a human resource management perspective using Fault Tree Analysis (FTA). Based on data collected through questionnaires, interviews, and project documentation, the top event of the analysis was defined as project delay. The FTA model decomposed this top event into five main intermediate events related to human resource management factors, namely ineffective workforce planning, poor inter-division coordination, low discipline and attendance, low motivation and competency, and suboptimal project performance. The results of the Fault Tree Analysis indicate that project delay is primarily triggered by ineffective workforce planning and poor coordination among project teams. These two factors form the most critical causal paths leading to the top event. Ineffective workforce planning is mainly caused by an insufficient number of workers and inaccurate workforce planning, which result in work disruptions and reduced productivity. Meanwhile, poor inter-division coordination is driven by reliance on informal communication channels and the absence of regular coordination meetings, leading to delays in decision-making and task execution.

Additional contributing factors include high absenteeism and labor turnover, which reflect low discipline and attendance, as well as a lack of skilled workers and low work motivation, which further reduce labor productivity. Suboptimal project performance, represented by unmet weekly targets and delayed problem resolution, acts as an amplifying factor that accelerates schedule delays. Overall, the results demonstrate that human resource-related factors are structurally interconnected and collectively contribute to project delays through OR-gate logic in the fault tree, indicating that the occurrence of any single critical factor can significantly increase the likelihood of delay. The main root causes of project delay identified through Fault Tree Analysis are summarized in Table 1.

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Table 1. Rules Root Causes of Project Delay Based on Fault Tree Analysis (FTA)

Level	Code	Factor Description	Explanation
Top Event	T	Project Delay	The main failure event indicating that the project completion exceeds the planned schedule.
Intermediate Event	X1	Ineffective Workforce Planning	Delays caused by poor labor planning, including inaccurate estimation of workforce needs and insufficient number of workers.
Basic Event	X1.1	Insufficient Number of Workers	Lack of available manpower results in low productivity and work interruptions.
Basic Event	X1.3	Inaccurate Workforce Planning	Inaccurate planning of labor requirements leads to mismatches between workload and available resources.
Intermediate Event	X2	Poor Inter-Division Coordination	Weak coordination between project divisions leads to miscommunication and delayed execution.
Basic Event	X2.2	Coordination Only via WhatsApp	Reliance on informal communication channels reduces clarity and accountability in coordination.
Basic Event	X2.3	Absence of Daily Coordination Meetings	Lack of routine coordination meetings causes delays in decision-making and problem resolution.
Intermediate Event	X4	Low Discipline and Attendance	Workforce discipline issues negatively affect work continuity and productivity.
Basic Event	X4.1	High Absenteeism	Frequent worker absences reduce effective working hours and slow project progress.
Basic Event	X4.2	High Labor Turnover	High turnover disrupts workflow and requires repeated training of new workers.
Intermediate Event	X5	Low Motivation and Competency	Low worker motivation and skill levels reduce work efficiency and quality.
Basic Event	X5.1	Lack of Skilled Workers	Insufficient skilled labor increases errors and rework.
Basic Event	X5.3	Low Work Motivation	Low motivation reduces productivity and commitment to project targets.
Intermediate Event	Z	Suboptimal Project Performance	Overall project performance does not meet planned targets, accelerating delays.
Basic Event	Z1	Weekly Targets Not Achieved	Planned weekly progress targets are not met due to accumulated delays.
Basic Event	Z3	Delayed Problem Resolution	Slow response to on-site problems exacerbates schedule deviations.

As shown in Table 1, ineffective workforce planning and poor inter-division coordination represent the most critical contributors to project delay, supported by multiple basic events related to human resource management.

Discussion

The findings of this study confirm that project delays in hospital construction projects are not solely caused by technical or material-related issues but are strongly influenced by human resource management deficiencies. From a theoretical perspective, these results are consistent with construction management theory, which emphasizes workforce planning, coordination, and supervision as key determinants of project performance. The dominance of ineffective workforce planning as a root cause supports prior studies that identify labor availability and planning accuracy as critical factors in maintaining project schedules. In complex projects such as hospitals, inaccurate estimation of workforce requirements can lead to cascading delays across multiple work packages. The results also align with coordination theory, which highlights the importance of structured communication and formal coordination mechanisms in managing interdependent tasks. The use of Fault Tree Analysis provides a methodological novelty compared to conventional delay studies that rely primarily on descriptive statistics or ranking methods. Unlike previous approaches, FTA enables a structured visualization of cause–effect relationships

and reveals how multiple human resource–related factors interact to produce project delays. This structural insight represents the main academic contribution of the study, as it extends delay analysis literature by applying a system-based and deductive method to human resource management issues in hospital construction projects. From a practical standpoint, the findings suggest that improving workforce planning accuracy, establishing formal coordination routines, strengthening supervision, and enhancing worker motivation are essential strategies to mitigate project delays. By addressing the root causes identified through FTA, project managers can implement targeted interventions rather than reactive corrective actions.

CONCLUSION

This study demonstrates that project delays in hospital construction projects are predominantly driven by human resource management–related factors rather than purely technical issues. Using Fault Tree Analysis (FTA), the research reveals that ineffective workforce planning and poor inter-division coordination constitute the most critical root causes of project delays. These factors generate cascading effects such as low productivity, rework, unmet weekly targets, and delayed problem resolution, which collectively increase the likelihood of schedule overruns. From a scientific perspective, this study contributes to the construction management literature by extending the application of Fault Tree Analysis to the domain of human resource management in hospital construction projects. Unlike conventional delay studies that rely on descriptive rankings or statistical correlations, the FTA approach provides a structured and deductive representation of causal relationships among delay factors. This methodological contribution offers a clearer understanding of how individual human resource issues interact within a system to produce project delays.

Several limitations should be acknowledged. The analysis is based on a single case study, which may limit the generalizability of the findings to other types of construction projects. In addition, the study focuses on qualitative causal relationships without incorporating probabilistic or quantitative weighting of fault tree events. Future research is therefore recommended to apply probabilistic Fault Tree Analysis or integrate FTA with other multi-criteria decision-making methods to quantify the relative importance of delay factors. Further studies may also expand the scope to include multiple projects or compare hospital projects with other complex building types to enhance external validity. Practically, the findings of this study can be used by project managers as a decision-support tool to design proactive risk mitigation strategies focusing on workforce planning accuracy, formal coordination mechanisms, and workforce development.

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