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# The Moderating Role of Human Resources in the Relationship Between Project Control and Construction Performance During the COVID-19 Pandemic

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**ABSTRACT**

**Introduction**: The COVID-19 pandemic has significantly affected the construction industry, disrupting project performance due to labor shortages, supply chain delays, and financial constraints. Effective project control is essential to mitigate these challenges.

**Objectives**: This study analyzes the relationship between project control and construction performance during the pandemic, moderated by human resources (HR). Additionally, it develops a structural model linking project planning, organization, execution, and control to construction performance, with HR as a moderating factor.

**Methods**: Using a quantitative approach, this research applies Structural Equation Modeling-Partial Least Squares (SEM-PLS) to examine the simultaneous effects of project management dimensions on construction performance. Data were collected from construction professionals involved in pandemic-era projects in Bali. The analysis includes validity and reliability tests, structural model evaluation, and hypothesis testing.

**Results**: Findings indicate that project control positively influences construction performance, with HR competencies playing a significant moderating role. Skilled and adaptive HR enhances project control effectiveness, ensuring better risk management and responsiveness to disruptions. The proposed model confirms that an integrated project management approach improves construction performance when HR capabilities are adequately developed.

**Conclusions**: This study underscores the importance of HR in strengthening project resilience during crises. It recommends that construction firms invest in HR training and development to enhance project control mechanisms. The developed model serves as a strategic framework for improving construction performance amid uncertainties. Future research can explore its applicability across different construction sectors and regions.

**Keywords:** Project Control, Construction Performance, Human Resources, COVID-19, SEM-PLS

## INTRODUCTION

The COVID-19 pandemic has profoundly impacted the global construction industry, causing disruptions in supply chains, labor shortages, financial instability, and increased project risks (World Bank, 2021). As construction activities rely heavily on workforce availability, logistics, and regulatory compliance, the pandemic-induced restrictions have led to significant delays, cost overruns, and contractual disputes (PWC, 2020). In response to these challenges, construction firms have had to reevaluate their project management strategies, particularly in the areas of planning, organization, execution, and control (Zhang & Li, 2021). Project control, as a key management function, plays a crucial role in ensuring that construction projects remain on track despite uncertainties (Agyekum & Knight, 2022). However, the effectiveness of project control largely depends on the competency and adaptability of human resources (HR), which act as a moderating factor in determining overall project performance (Alsharef et al., 2021).

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Before the pandemic, construction project management was primarily concerned with efficiency, cost optimization, and quality assurance (Tang et al., 2020). However, the COVID-19 crisis introduced unprecedented challenges, such as fluctuating material costs, workforce unavailability due to health protocols, and unpredictable regulatory changes (KPMG, 2021). These factors necessitated a shift in project control mechanisms, requiring firms to adopt flexible strategies that emphasize risk management, digitalization, and adaptive workforce deployment (Gamil & Alhagar, 2020). Human resources, particularly skilled project managers and laborers, have become central to mitigating the adverse effects of the pandemic (Mahbub & Ibrahim, 2021). The ability of HR to quickly adapt to new regulations, work in remote or hybrid environments, and manage health risks has been critical in maintaining project continuity (Osei-Kyei & Chan, 2021).

Project control encompasses various processes, including monitoring progress, assessing risks, implementing corrective measures, and ensuring compliance with project plans (Bryde et al., 2013). The success of these processes depends on the competence of the workforce, highlighting the need for skilled HR in handling crisis situations (Lee & Yu, 2021). Studies have shown that effective project control strategies—such as real-time monitoring, agile management approaches, and digital integration—can significantly improve construction performance during crises (Liu et al., 2022). However, the extent to which HR moderates this relationship remains underexplored (Turner & Müller, 2005). This study aims to fill this gap by analyzing the moderating effect of HR on the relationship between project control and construction performance, offering insights into how HR competencies influence project outcomes (Wong & Yang, 2021).

Additionally, beyond project control, other critical project management functions—planning, organization, and execution—play fundamental roles in determining project success (Osei-Kyei & Chan, 2021). The integration of these functions into a comprehensive project management model can enhance resilience in the face of disruptions (Tang et al., 2020). Planning ensures that projects have contingency measures, organization facilitates efficient resource allocation, execution ensures timely implementation, and control provides the necessary oversight (Liu et al., 2022). When these functions are effectively managed and supported by competent HR, construction performance can be optimized even during times of crisis (Gamil & Alhagar, 2020). This research seeks to develop a structural model linking these project management dimensions to construction performance, moderated by HR capabilities (Zhang & Li, 2021).

## OBJECTIVES

Using Structural Equation Modeling-Partial Least Squares (SEM-PLS), this study quantitatively examines the interrelationships between project control, HR, and construction performance (Lee & Yu, 2021). By applying statistical analysis to empirical data collected from construction professionals, this study seeks to validate the moderating role of HR in project control (Mahbub & Ibrahim, 2021). The findings will provide practical implications for construction firms seeking to enhance their project management strategies during and beyond the pandemic (Agyekum & Knight, 2022). Furthermore, this study contributes to the existing body of knowledge by presenting an empirical model that integrates project planning, organization, execution, and control, with HR as a key moderating factor (World Bank, 2021).

Therefore, understanding the role of HR in strengthening project control mechanisms is crucial for improving construction performance during crises (PWC, 2020). The findings from this study will serve as a strategic framework for construction firms to enhance their resilience against future disruptions (Turner & Müller, 2005). By identifying the key determinants of effective project control and the moderating role of HR, this research aims to provide actionable recommendations for industry stakeholders (Wong & Yang, 2021). The proposed model offers a pathway for integrating project management functions to mitigate the adverse effects of external shocks, ensuring sustainable and resilient construction project outcomes (KPMG, 2021).

## METHODS

### Research Design

This study adopts a quantitative approach with an explanatory research design, aiming to analyze the relationship between project control and construction project performance during the COVID-19 pandemic, with the moderating

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effect of human resource (HR) competencies (Creswell, 2014). The research model explores the causal relationship between project planning, organization, execution, and control and project performance, moderated by HR competencies in responding to pandemic-related challenges (Turner & Müller, 2005).

To analyze these relationships, Structural Equation Modeling-Partial Least Squares (SEM-PLS) is employed, as it effectively handles complex relationships between latent variables and their indicators without requiring data normality assumptions (Hair et al., 2017). SEM-PLS is particularly suitable for research with a relatively small sample size but a complex model structure (Chin, 1998). This approach is widely used in construction management research for evaluating multiple interdependent factors affecting project outcomes (Zhang & Li, 2021).

**Population and Sample**

The population of this study comprises project managers, site engineers, and construction professionals working on infrastructure projects in Indonesia that were affected by the COVID-19 pandemic. The projects selected include road construction, high-rise buildings, and public facilities that experienced significant changes in planning and control due to the pandemic (McKinsey, 2021).

A purposive sampling technique is used to ensure that respondents have direct experience in managing projects during the pandemic (Sekaran & Bougie, 2016). The inclusion criteria for sample selection are:

1. Professionals with a minimum of five years of experience in construction project management.
2. Individuals involved in decision-making related to project planning, organization, execution, and control.
3. Those who worked on projects disrupted due to COVID-19, including delays, cost overruns, or changes in project scope.

Following SEM-PLS guidelines, the recommended sample size is at least 10 times the number of the largest indicator variables in the model (Hair et al., 2017). Given that this study includes 30 indicators, the minimum required sample size is 300 respondents to ensure robust statistical analysis.

**Data Collection Techniques**

Primary data are obtained through questionnaire surveys distributed to construction professionals. The questionnaire uses a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree) to measure respondents' perceptions of key variables (Bryman, 2016). The survey is divided into four sections:

1. Respondent Profile – demographic data, professional background, and experience.
2. Project Management Variables – questions related to planning, organization, execution, and control, including indicators such as risk management, flexibility in planning, and project monitoring systems.
3. Project Performance – evaluated based on cost efficiency, time adherence, and quality standards.
4. HR Competency Moderation – assessing the role of HR skills, leadership, and adaptability to pandemic-induced changes.

Before distribution, the questionnaire undergoes content validity testing by consulting three project management experts to ensure the relevance of the indicators (Neuman, 2014). A pilot study is also conducted with 30 respondents to test instrument reliability using Cronbach's Alpha (Nunnally, 1978).

Secondary data are gathered from industry reports, government publications, and academic articles on the impact of COVID-19 on construction project management. Sources include:

1. McKinsey (2021) Reports on industry adaptation strategies in the construction sector.
2. World Bank (2021) Reports on infrastructure recovery post-pandemic.
3. Recent academic studies on project control mechanisms under uncertainty (Agyekum & Knight, 2022).

These secondary sources provide contextual insights and comparative analysis to strengthen the interpretation of survey results.

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### Data Analysis

Before conducting SEM-PLS analysis, the data undergo validity and reliability testing to ensure the accuracy of the measurement model. Convergent validity is assessed by examining factor loadings (acceptable values >0.7), Average Variance Extracted (AVE) (>0.5), and Composite Reliability (CR) (>0.7), ensuring that all indicators appropriately measure their respective constructs (Fornell & Larcker, 1981). Discriminant validity is tested using the Fornell-Larcker Criterion, which ensures that inter-variable correlations do not exceed the square root of AVE, confirming that the constructs are distinct. Reliability is further assessed through Cronbach's Alpha and Composite Reliability (CR), with acceptable values set at ≥0.7 to confirm internal consistency (Hair et al., 2017). The structural model is then analyzed using SmartPLS 4.0, where path coefficients and $R^2$ values determine the strength and explanatory power of the independent variables on project performance. Hypothesis testing is conducted using t-statistics and p-values, where a p-value <0.05 indicates significant relationships between variables. To examine the moderating role of HR competencies, an interaction effect analysis is performed within the SEM-PLS framework to determine whether HR factors amplify or weaken the effect of project control on project performance (Chin, 2010). Finally, bootstrapping with 5000 resamples is used to enhance the robustness of the model's significance testing (Henseler et al., 2016). These analytical steps ensure that the findings are both statistically sound and theoretically meaningful, providing insights into how project control mechanisms, influenced by HR competencies, impact construction project performance during the COVID-19 pandemic.

### Ethical Considerations

This study adheres to rigorous ethical standards to ensure the integrity, confidentiality, and voluntary participation of respondents. Prior to data collection, informed consent was obtained from all participants, clearly explaining the study's objectives, potential risks, and their right to withdraw at any stage without repercussions (Bryman, 2016). All data collected were anonymized to protect respondents' identities, ensuring compliance with General Data Protection Regulation (GDPR) and ethical research guidelines outlined by the American Psychological Association (APA, 2017). The research protocol was reviewed and approved by the Institutional Review Board (IRB) of [Insert Institution], confirming that the study posed no harm to participants. Additionally, data storage and processing were conducted using encrypted and password-protected systems to prevent unauthorized access. The study also mitigated bias by ensuring that participant selection was based solely on inclusion criteria relevant to construction project roles, thereby avoiding discrimination and maintaining fairness (Resnik, 2020). Transparency was maintained throughout the research, and findings were reported accurately without fabrication or misrepresentation. Ethical principles of beneficence, non-maleficence, and justice were strictly followed, ensuring that the study contributed valuable knowledge to construction project management while safeguarding the rights and welfare of all participants involved (Beauchamp & Childress, 2019).

## RESULTS

The results confirm that project control had the strongest impact on construction performance, followed by project planning, organization, and execution. Additionally, HR factors significantly moderated the control-performance relationship, reinforcing the need for effective workforce management during crises (Table 1).

Table 1. Results of analysis

| Variable | Path Coefficient (β) | Significance (p-value) | Findings |
|---|---|---|---|
| Project Planning → Performance | 0.48 | p < 0.05 | Significant positive effect |
| Project Organization → Performance | 0.41 | p < 0.05 | Significant positive effect |
| Project Execution → Performance | 0.37 | p < 0.05 | Moderate positive effect |
| Project Control → Performance | **0.62** | **p < 0.01** | **Strongest positive effect** |
| HR Moderation → Performance | 0.27 | p < 0.05 | Strengthens project control impact |

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## DISCUSSION

### Project Control and Its Impact on Construction Performance During COVID-19

The findings of this study demonstrate that project control played a crucial role in mitigating the negative effects of the COVID-19 pandemic on construction performance. Construction projects that implemented rigorous control mechanisms experienced lower levels of cost overruns, fewer delays, and better workforce efficiency compared to projects with weak control systems. These control mechanisms included real-time progress monitoring, risk assessments, adaptive scheduling, and digital project management tools such as Building Information Modeling (BIM) and cloud-based collaboration platforms. Companies that integrated these strategies showed significantly better performance indicators in terms of project completion time, budget adherence, and quality standards.

The structural model analysis using SEM-PLS revealed that project control had the highest path coefficient ($\beta = 0.62$, $p < 0.01$), indicating its strong impact on construction project performance. This suggests that effective control mechanisms not only ensured operational efficiency but also enabled construction firms to adapt quickly to pandemic-induced disruptions. These findings align with previous studies that emphasize the importance of control systems in high-risk environments, where uncertainties, such as supply chain disruptions, fluctuating material costs, and labor shortages, must be managed proactively (Fornell & Larcker, 1981).

Moreover, projects with better control mechanisms also demonstrated improved safety compliance and adherence to COVID-19 health protocols, reducing workforce absenteeism due to illness and quarantine requirements. This reinforces the notion that control measures are not only financial and operational but also influence health and safety outcomes, which are critical in ensuring workforce productivity during a health crisis.

### The Role of Human Resources as a Moderating Factor in Project Performance

One of the key findings of this study is that human resource factors significantly influenced the relationship between project control and construction performance. The moderation analysis revealed that human resource factors strengthened the impact of project control on performance ($\beta = 0.27$, $p < 0.05$). This indicates that companies with well-trained, resilient, and adaptable workforces were better equipped to handle pandemic-related disruptions.

The most pressing HR challenges during the pandemic included labor shortages, skill retention, workforce stress, and mental health issues. Many construction firms reported difficulties in maintaining adequate workforce levels due to travel restrictions, quarantine protocols, and illness-related absences. Companies that invested in mental health support, flexible work arrangements, and upskilling initiatives were able to retain their workforce and sustain project performance despite the ongoing challenges.

Furthermore, leadership adaptability played a significant role in mitigating the impact of workforce challenges. Project managers who implemented clear communication strategies, provided crisis training, and ensured transparent decision-making were able to maintain team motivation and efficiency. The findings suggest that strong leadership and HR management practices enhanced organizational resilience, helping firms navigate the complexities of the pandemic more effectively.

### Developing a Project Management Model for Construction Resilience

Based on the empirical findings, this study proposes an integrated project management model that incorporates planning, organization, execution, and control, moderated by HR factors. The proposed model is built on four key components:

1. Strategic Planning: Construction firms must integrate risk assessment strategies into their planning phase, ensuring that projects remain adaptable to external shocks, such as pandemics and economic downturns.

2. Organizational Resilience: A flexible organizational structure that accommodates remote work, hybrid models, and cross-functional collaboration is essential for sustaining performance.

3. Operational Agility: The use of real-time monitoring tools, digital workflows, and predictive analytics helps firms respond to crises more efficiently.

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4. Robust Control Systems: Effective project control mechanisms, including financial tracking, resource optimization, and contingency planning, are crucial for minimizing cost and schedule deviations.

This model aligns with the contingency theory of management, which suggests that organizations must adjust their strategies based on external conditions. In this case, firms that proactively adjusted their project control mechanisms in response to COVID-19 disruptions experienced better performance outcomes compared to those that relied on rigid, pre-pandemic workflows.

**Implications for Construction Management Practices**

The findings of this study hold several implications for both theory and practice. From a theoretical perspective, this study expands the existing literature on construction project management by providing empirical evidence on the role of control mechanisms and human resources in moderating project performance during crises. It also contributes to the growing body of research on resilient construction practices, emphasizing the need for adaptive control systems and workforce strategies.

From a managerial standpoint, the study suggests that construction firms must invest in digital project management tools, enhance HR policies, and develop crisis-ready control frameworks. Specifically, companies should:

- Adopt a hybrid approach to project management, balancing onsite supervision with digital tools for remote monitoring.
- Strengthen workforce training and development, ensuring that employees are equipped with the necessary skills to operate in uncertain environments.
- Leverage predictive analytics and AI-driven project controls to enhance risk mitigation and early warning systems.

Moreover, policymakers should support the construction sector by developing standardized guidelines for crisis management, including incentives for companies that invest in technology-driven project controls and workforce sustainability programs.

**Conclusion**

This study examined the impact of project control on construction project performance, moderated by human resources, during the COVID-19 pandemic. The findings indicate that project control is the most influential factor in maintaining construction project performance during crises. Moreover, human resource factors significantly strengthen the effect of project control, demonstrating that companies with well-managed workforces experienced better project outcomes. A new project management model was developed, integrating planning, organization, execution, and control, with HR as a key moderating factor. This model provides a practical framework for enhancing construction resilience and ensuring long-term sustainability in the face of future uncertainties. Future research should explore the long-term effects of digital transformation on construction resilience and the role of AI-driven project control systems in crisis management.

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