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Research Article

MEDIATING FINANCIAL AND HSE ROLES IN RISK MANAGEMENT IMPACT ON MYANMAR CONSTRUCTION SUCCESS

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Abstract
This study seeks to examine the effects of risk management strategies on the success of construction projects in Myanmar, a country with a rapidly expanding construction industry that has received little scholarly attention. Using a combination of traditional paper-based surveys and online questionnaires, a comprehensive dataset has been compiled for this study. The participants, which included project managers, project engineers, safety engineers, financial experts, and project proprietors, played a crucial role in providing diverse perspectives. From the initial sample of 500 questionnaires, a response rate of 84.6 percent yielded 397 valid responses. Using Smart PLS as a data analysis instrument, the study deconstructed risk management into its fundamental components: identification, analysis, response, and monitoring. In addition to the immediate effects, the study reveals the intermediate roles played by financial performance and Health, Safety, and Environment (HSE) issues. The findings indicate a correlation between the implementation of effective risk management strategies and the overall success of construction projects. The intermediate effect of financial performance and HSE performance strengthens the relationship between these variables. This research offers significant academic and practical insights by providing evidence-based strategies to improve risk management practices in Myanmar's rapidly developing construction industry.

Keywords: Construction Project Success, Financial Performance, HSE Performance, Myanmar Construction Industry, Risk Management

INTRODUCTION

The construction industry serves as a cornerstone for economic development and public welfare in modern societies, with Myanmar being no exception. Since the liberalization of its economy and the influx of foreign investment in the early 2010s, Myanmar has seen a surge in construction activities, especially in major urban centers like Yangon and Mandalay (Soe et al., 2022). These cities are burgeoning with infrastructure projects, residential constructions, and commercial developments, signaling the industry's crucial role in the nation's progress.

However, this rapid expansion is not without its challenges. The industry grapples with regulatory inconsistencies, a dearth of skilled labor, and restricted access to cutting-edge technologies (IPSOS, 2017). These issues are further complicated by the high-risk nature of construction projects, which often experience cost overruns, time delays, and safety incidents (Hossain et al., 2020). It becomes evident that these challenges are not merely operational but also strategic, thereby underlining the necessity of robust risk management practices (Yusoff et al., 2021).

In addition to these insights, Al Frijat, Albawwat, and Elamer (2024) highlighted the importance of corporate social responsibility in enhancing organizational outcomes in turbulent environments, emphasizing the need for robust risk management to ensure financial performance and sustainability. Additionally, Ateeq et al. (2024) underscored the role of human resource management and occupational health and safety in sustaining organizational outcomes, further stressing the importance of comprehensive risk management strategies in achieving project success. Despite the acknowledged importance of risk management, evidence suggests that its application within Myanmar's construction sector is far from ideal. A substantial number of projects continue to show deficiencies in risk identification, assessment, mitigation, and monitoring, often leading to unfavorable outcomes (Obondi, 2022). In light of this, the industry's existing risk management practices warrant critical evaluation and improvement. This becomes all the more pertinent as the sector experiences increased regulatory scrutiny, particularly concerning Health, Safety, and Environmental (HSE) standards (Bayraktar, 2020).

Given the substantial role of financial and HSE performance as key success metrics for construction projects, this study aims to delve into how these variables mediate the impact of risk management practices on project outcomes. It seeks to offer nuanced insights into the specific context of Myanmar, thereby addressing an existing gap in both academic literature and practical application. The body of knowledge on risk management in international building projects has been constantly expanding. In the context of Myanmar's rapidly growing construction industry, it is important to note that this topic is not receiving enough attention (Htoo et al., 2023). Despite the acknowledged importance of effective risk management in ensuring project success, there is little research on how risk management techniques affect construction project outcomes in Myanmar (Aung et al., 2023).

The issue is further compounded by the insufficient comprehension of the mediating functions that Financial and HSE performances fulfill in this association. The existence of a knowledge gap has practical consequences, especially for stakeholders that seek to enhance risk management techniques in order to achieve project success (Aung et al., 2023). Hence, the primary objective of this research is to examine the impact of risk management systems, specifically encompassing the stages of detection, analysis, response, and monitoring, on the achievement of construction project objectives in Myanmar. Furthermore, the present study aims to investigate the mediating role of financial and HSE performance in these interactions, providing a more comprehensive comprehension that can inform both scholarly discussions and real-world implementations.

There is a considerable body of research available regarding the significance of risk management in the construction industry. However, there is a dearth of studies that specifically examine the relationship between risk management techniques and their mediating variables, namely financial and HSE performance. This gap in knowledge is particularly evident within the context of Myanmar. The majority of contemporary research examines risk management strategies or concentrates exclusively on financial and HSE results, with limited integration of these variables within a holistic framework. The lack of a comprehensive strategy to comprehending risk management in construction projects creates a significant void in both scholarly literature and real-world implementations. Therefore, the main goal of this study is to close this gap by looking at the performance of the financial and HSE intermediary functions in the relationship between risk management techniques and the accomplishment of building project goals in Myanmar.

The study will offer practitioners, especially those in the construction industry in Myanmar, evidence-based strategies for effective risk management amidst socio-economic and political instability. Such findings can guide not only project managers but also policy-makers and regulators in adapting and fortifying risk management frameworks suited to this environment. By addressing the gap in literature concerning the role of external factors on risk management in developing economies, particularly Myanmar, this study will contribute a unique perspective to the global discourse on construction project management. It opens avenues for further research into the complexities of managing projects in unstable environments.

The primary purpose of this study is to investigate how risk management techniques affect the results of construction projects in Myanmar, with an emphasis on the impact of current political turbulence and economic instability brought on by the COVID-19 epidemic. This study's goal is to investigate the relationships between financial performance and HSE performance. The study provides a comprehensive analysis of risk management in Myanmar's construction industry. However, the use of survey data collected within a specific time frame limits its applicability. It is crucial to remember that the conclusions from this study may not be generalizable to times when there are different economic or political conditions, as well as to other areas of the industry.

LITERATURE REVIEW

This part is introduced by two essential visual aids: Figure 1 illustrates the Conceptual Framework, whereas Figure 2 delineates the Hypotheses Diagram. The diagrams in question function as complete visual aids that delineate the theoretical structures of the subject and the interconnections between them. The primary objective of this study is to investigate the impact of risk management practices on project success. This investigation will focus on the direct and indirect effects of risk management practices, which are mediated by two key variables: Financial Performance and HSE Performance.

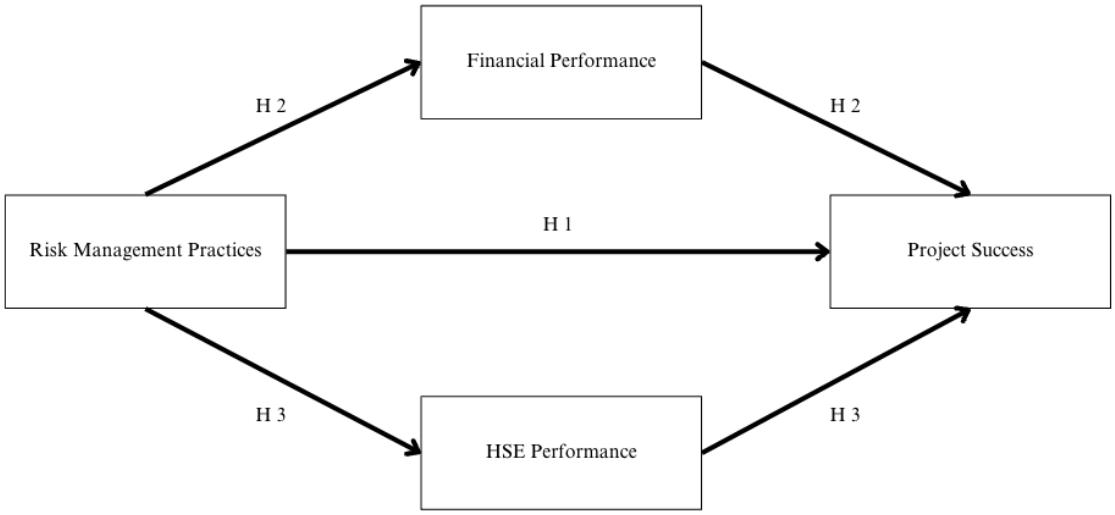

Figure 1. Conceptual Framework of the Study

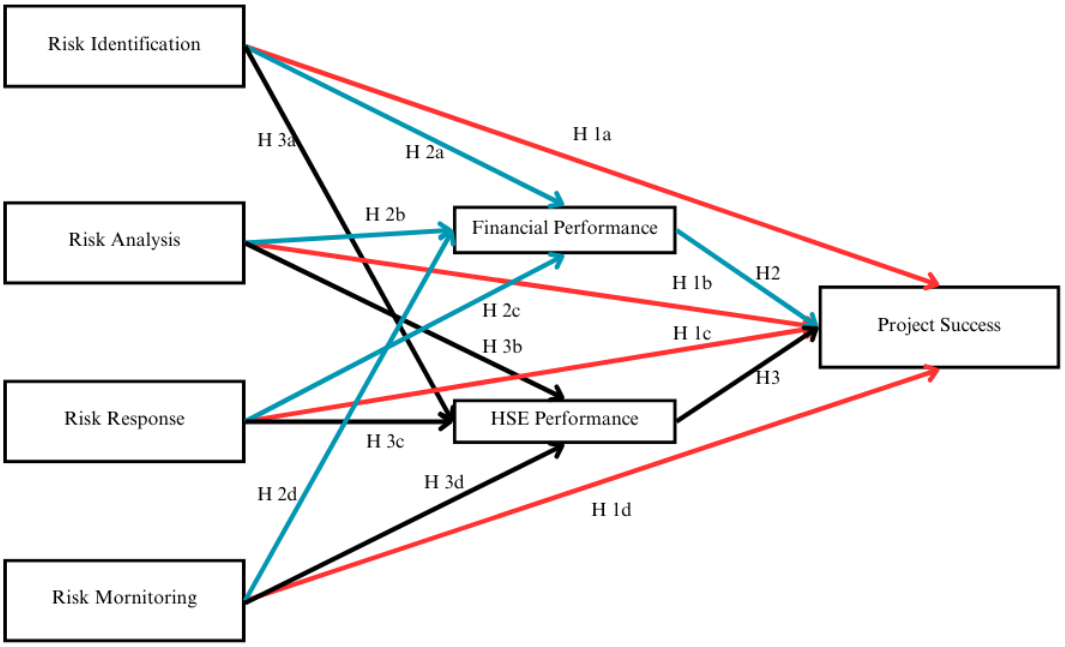

Figure 2. Hypotheses Diagram of the Study

To answer the above research questions, the following hypotheses have been formulated:
H1: Influence of Risk Management Practices on Project Success
H1a: Effective Risk Identification Positively Influences Project Success
H1b: Thorough Risk Analysis Positively Influences Project Success
H1c: Well-Implemented Risk Response Strategies Positively Influence Project Success
H1d: Regular Risk Monitoring and Evaluation Positively Influence Project Success

H2: Mediation by Financial Performance
H2a: Risk Identification and Project Success are Mediated by Financial Performance
H2b: Risk Analysis and Project Success are Mediated by Financial Performance
H2c: Risk Response and Project Success are Mediated by Financial Performance
H2d: Risk Monitoring and Project Success are Mediated by Financial Performance

H3: Mediation by Health, Safety, and Environmental (HSE) Performance
H3a: Risk Identification and Project Success are Mediated by HSE Performance
H3b: Risk Analysis and Project Success are Mediated by HSE Performance
H3c: Risk Response and Project Success are Mediated by HSE Performance
H3d: Risk Monitoring and Project Success are Mediated by HSE Performance

Overview of Risk Management Importance

The construction sector is characterized by inherent risks stemming from the participation of several stakeholders, complex procedures, and unanticipated events that have the potential to disrupt projects (Htet et al., 2023). The significance of proficient risk management in the construction industry has been widely recognized as a fundamental element for achieving project success (Pirotti et al., 2020).

Core Stages of Risk Management

The four key stages of risk management—identification, analysis, response, and monitoring are universally accepted yet adapted differently depending on regional constraints and project requirements (Srinivas, 2019).

Identification Phase: This initial phase necessitates a comprehensive mapping of potential risks, from environmental factors to stakeholder dynamics (Jiang et al., 2020). Tools like SWOT analysis, Delphi methods, and risk breakdown structures are commonly employed (Moktadir et al., 2018).

Analysis Phase: Quantitative and qualitative methodologies are often used for risk assessment. These methodologies include, but are not limited to, Probability-Impact Grids, Monte Carlo Simulation, and Decision Tree Analysis (Jarrah et al., 2022).

Response Phase: Effective risk response necessitates a multifaceted approach that is deeply rooted in traditional methods. Such traditional methods often involve expert judgment, risk matrices, and decision trees for assessing and responding to potential risks (Cagliano et al., 2014). These conventional techniques have been the cornerstone of risk management strategies, especially where cutting-edge technologies like AI-based predictive models are not yet fully integrated.

Monitoring Phase: This continuous process involves the use of Key Performance Indicators (KPIs) to track the effectiveness of risk response strategies, often requiring regular updates to adapt to project evolutions (Zhang, Y. & Guan, X., 2021).

Financial Performance

The academic community has shown a great deal of interest in the connection between risk management and financial success in construction projects. Several studies indicate that effective risk management strategies lead to improved financial outcomes. For instance, Aung et al. (2023) demonstrated that projects with sound financial planning often have a higher efficacy in risk mitigation, leading to better overall project success. Another study by Zaman et al (2017) explored how financial risk management techniques, such as sensitivity analysis and Monte Carlo simulations, could predict financial performance accurately. They concluded that the adoption of such techniques significantly improved project ROI and reduced the likelihood of financial failure.

Health, Safety, and Environmental (HSE) Performance

Research into the interplay between HSE performance and risk management is growing but remains an area requiring more focused studies. Hu (2019) found that robust HSE practices correlated strongly with better risk mitigation in construction projects. Another seminal work by Ahmetoğlu and Tanik (2020) explored how environmental factors, including waste management and carbon footprint, play a crucial role in risk management strategies. The study also pointed out that a proactive HSE policy could lead to both direct and indirect benefits, such as reduced insurance costs and enhanced company reputation.

Project Success

Project success in the construction industry is a multi-faceted phenomenon often measured by factors like time, cost, quality, and stakeholder satisfaction. While traditional metrics are still widely used, there has been a gradual shift towards more comprehensive measures that include both financial and non-financial elements, such as sustainability and social impact (Gündüz, M. & Almuajebh, M., 2020). The success of a project is often seen as the ultimate validation of effective risk management (Jiang et al., 2022). Thus, understanding the full scope of what constitutes project success is critical for both researchers and practitioners aiming to improve risk management practices.

Recent studies have highlighted the evolving landscape of risk management in construction and its impact on project success. For example, Adamtey & Onsarigo (2018) demonstrated that integrating financial risk assessments into project planning significantly improves financial outcomes in construction projects in developing countries. Their findings align with the necessity for robust financial performance as a mediator in risk management effectiveness. Similarly, Adedokun and Egbelakin (2022) examined the influence of comprehensive HSE management on project success, showing a strong correlation between proactive HSE practices and reduced project delays and cost overruns. Furthermore, Nguyen et al. (2024) explored the role of cultural and socio-political factors in shaping risk management strategies in Southeast Asia, emphasizing the importance of context-specific approaches for effective risk mitigation. These studies reinforce the importance of tailored risk management practices that consider financial and HSE performance as critical mediators in achieving project success, particularly in the dynamic construction industry of Myanmar.

RESEARCH METHOD

To get fresh insights into this topic, the current study employs an exploratory research methodology to examine how risk management practices affect the results of construction projects in Myanmar. Particular attention is given to the mediating roles of Financial and HSE performance, a less-explored domain in existing literature yet highly relevant in the Myanmar construction sector. The Partial Least Squares (PLS) method, facilitated by the Smart PLS software, is chosen for data analysis due to its robust capabilities in handling complex models and accommodating smaller sample sizes.

Stratified random sampling is utilized in order to effectively capture the diverse nature of Myanmar's building industry. The industry is divided into different segments based on project type, size, and geographic location, with a special emphasis on Yangon and Mandalay. The final representative sample set is produced by combining random samples from each stratum.

A total of 500 questionnaires were distributed to a diversified group of industry professionals, encompassing project managers, project engineers, safety engineers, project finance personnel, and project owners. The distribution was facilitated through a hybrid approach, blending both physical and digital methods. This strategy yielded an impressive response rate of 84.6%, amassing 423 returned questionnaires. After rigorous data cleaning to omit incomplete or inconsistent responses, the final sample size was narrowed down to 397 valid responses. The survey featured questions on risk identification, risk analysis, risk response, risk monitoring, project financial performance, HSE performance, and overall project success. For the complete set of survey questions, see Appendix A.

The data for this study were gathered during six months, from January to June 2023. This timeline was strategically chosen to get a comprehensive view of the dynamics of Myanmar's construction industry at a period of substantial political and economic upheaval. The selected period also aligns with the post-COVID-19 recovery phase, which provides valuable insights into how construction projects adapt to and manage risks in a changing environment.

The questionnaire used in this study comprised **27 questions** distributed across six dimensions, ensuring comprehensive coverage of the study's focus areas. The dimensions and indicators of the questionnaire are detailed in Table 1 below. The reliability of the instrument was tested using Cronbach's alpha, with each dimension achieving an alpha value above 0.70, indicating acceptable reliability.

Table 1. Dimensions and Indicators of the Questionnaire

Dimension	Indicator	Number of Questions
Risk Identification	Identification of potential risks	4
Risk Analysis	Analysis of identified risks	4
Risk Response	Strategies to respond to risks	4
Risk Monitoring	Monitoring and reviewing risks	4
Project Financial Performance	Budget adherence, cost management	4
HSE Performance	Health, safety, environmental measures	4
Overall Project Success	Achievement of project goals, satisfaction	3

The reliability of the questionnaire was tested using Cronbach's alpha for each dimension. The Cronbach's alpha values are as follows: Risk Identification (0.838), Risk Analysis (0.809), Risk Response (0.770), Risk Monitoring (0.781), Project Financial Performance (0.752), HSE Performance (0.725), and Overall Project Success (0.761). These values indicate that the questionnaire is a reliable tool for assessing the various aspects of risk management and project performance in the Myanmar construction industry.

RESULTS AND DISCUSSION

In this section, descriptive statistics are tabulated to provide an analytical snapshot of the sample's demographic and professional characteristics. The tabulation offers an efficient yet comprehensive overview, thereby enhancing the study's validity and generalizability.

Table 2. Gender Distribution

Gender	Percentage	Number of Respondents
Male	65%	258
Female	35%	139

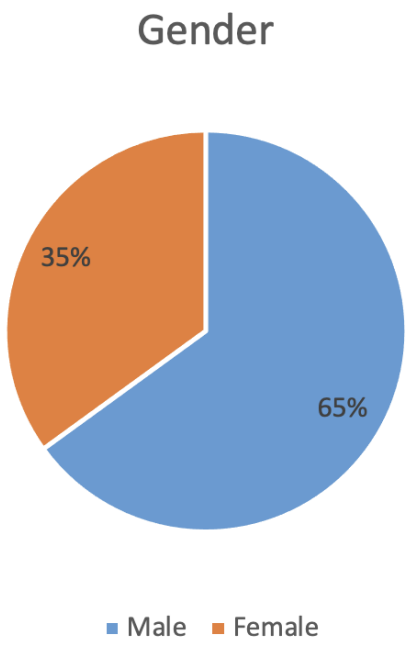

Figure 3. Pie Chart – Gender Distribution of Respondents

As delineated in Table 2 and Figure 3, the male respondents notably outnumbered the female counterparts, indicating a gender-skewed industry landscape in Myanmar.

Table 3. Age Distribution

Age Group	Percentage	Number of Respondents
Under 25	10%	40
25 to 30	30%	119
31 to 35	30%	119
36 to 40	16%	64
41 to 45	12%	48
Over 45	2%	7

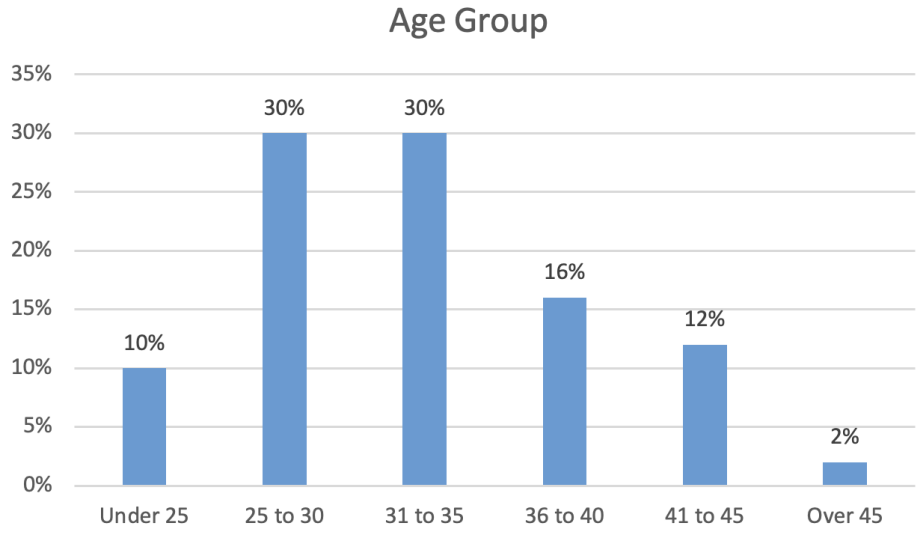

Figure 4. Bar Chart – Age Distribution of Respondents

Table 3 and figure 4 elucidates that the age distribution primarily hovers between 25 and 35 years, thereby encapsulating a largely youthful workforce within the industry.

Table 4. Educational Qualifications

Qualification	Percentage	Number of Respondents
Diploma Degree	10%	40
Bachelor Degree	60%	238
Master Degree	27%	107
Ph.D. Degree	3%	12

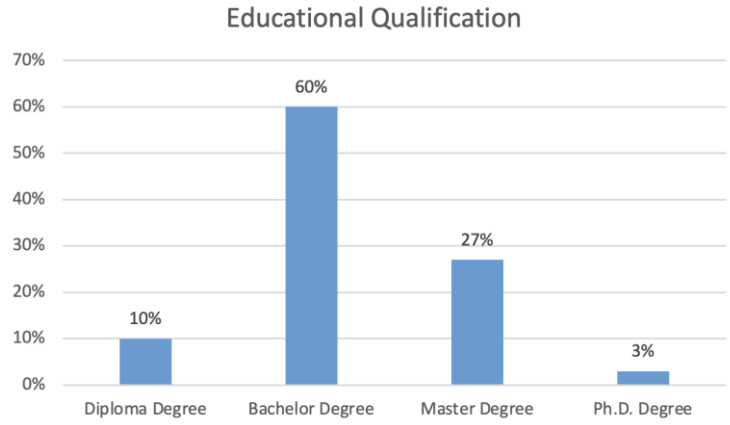

Figure 1: Bar Chart – Educational Qualification of Respondents.

Table 4 and Figure 5 highlights that the majority of respondents hold a Bachelor's Degree, thus demonstrating a generally well-educated sample.

Table 5. Professional Experience

Experience	Percentage	Number of Respondents
Under 5 years	15%	60
5 years to 10 years	30%	119
11 years to 15 years	20%	79
16 years to 20 years	20%	79

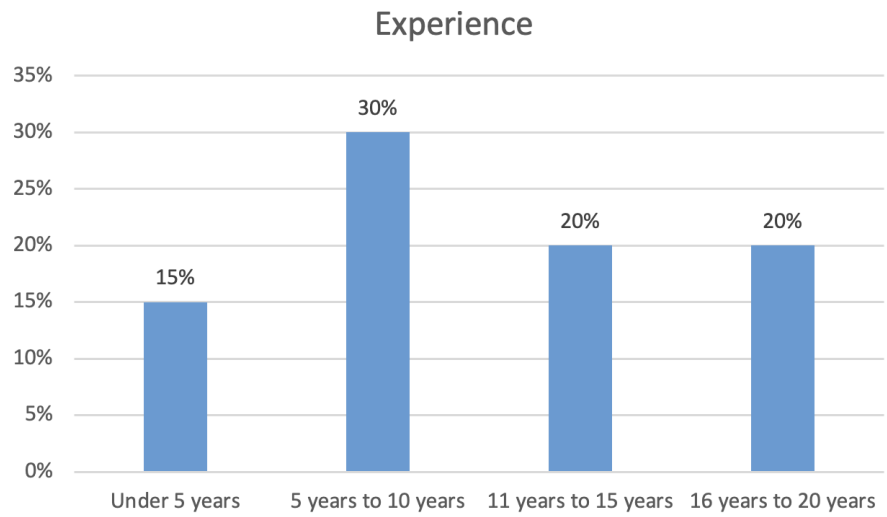

Figure 6: Bar Chart – Years of Experience of Respondents

Table 5 and Figure 6 reveals that the respondents come from a variety of experience levels, offering a multi-dimensional perspective on risk management practices in the Myanmar construction sector. In summation, the tables collectively depict a diverse profile of respondents, thereby enriching the study's context and scope for interpreting risk management practices and their subsequent impact on construction project success in Myanmar.

Risk Management Practices in Myanmar's Construction Industry

Reliability and Validity Metrics

In order to validate the effectiveness of our risk management system within the specific context of Myanmar's construction industry, a comprehensive set of reliability and validity assessments were conducted. The conducted tests encompassed the utilization of many metrics, including Cronbach's alpha, Composite Reliability (rho_a and rho_c), and Average Variance Extracted (AVE).

Table 6. Reliability and Validity Metrics

	Cronbach's alpha	Composite reliability (rho_a)	Composite reliability (rho_c)	Average variance extracted (AVE)
HSE Performance (Mediator)	0.725	0.730	0.829	0.548
Project Financial Performance (Mediator)	0.752	0.758	0.842	0.571
Project Success (Dependent Variable)	0.761	0.770	0.863	0.677
Risk Analysis	0.809	0.840	0.872	0.632
Risk Identification	0.838	0.881	0.889	0.669
Risk Monitoring	0.781	0.852	0.857	0.603
Risk Response	0.770	0.773	0.854	0.594

The metrics reported in Table 5 corroborate that the identified risk management practices are both reliable and valid, indicating their robustness in the Myanmar construction landscape.

Correlations Among Risk Management Constructs

Table 7. Correlation Matrix

	HSE Performance	Project Financial Performance	Project Success	Risk Analysis	Risk Identification	Risk Monitoring	Risk Response
HSE Performance		0.739	0.745	0.455	0.440	0.219	0.461
Project Financial Performance			0.804	0.437	0.309	0.146	0.639
Project Success				0.450	0.380	0.268	0.548
Risk Analysis					0.539	0.241	0.216
Risk Identification						0.094	0.153
Risk Monitoring							0.160
Risk Response							

An examination of the correlation matrix (Table 7) illustrates the interplay among various constructs involved in risk management, as well as their influence on project outcomes.

Explained Variance in Risk Management Constructs

Table 8. Explained Variance Metrics (R-Square)

	R-square	R-square adjusted
HSE Performance (Mediator)	0.29	0.283
Project Financial Performance (Mediator)	0.342	0.336
Project Success (Dependent Variable)	0.512	0.504

The R-square values indicate that our model accounts for approximately 28.3% of the variance in HSE Performance, 33.6% in Project Financial Performance, and 50.4% in Project Success. These values underscore the considerable influence of risk management practices on various facets of project performance.

Visualization of Risk Management Practices

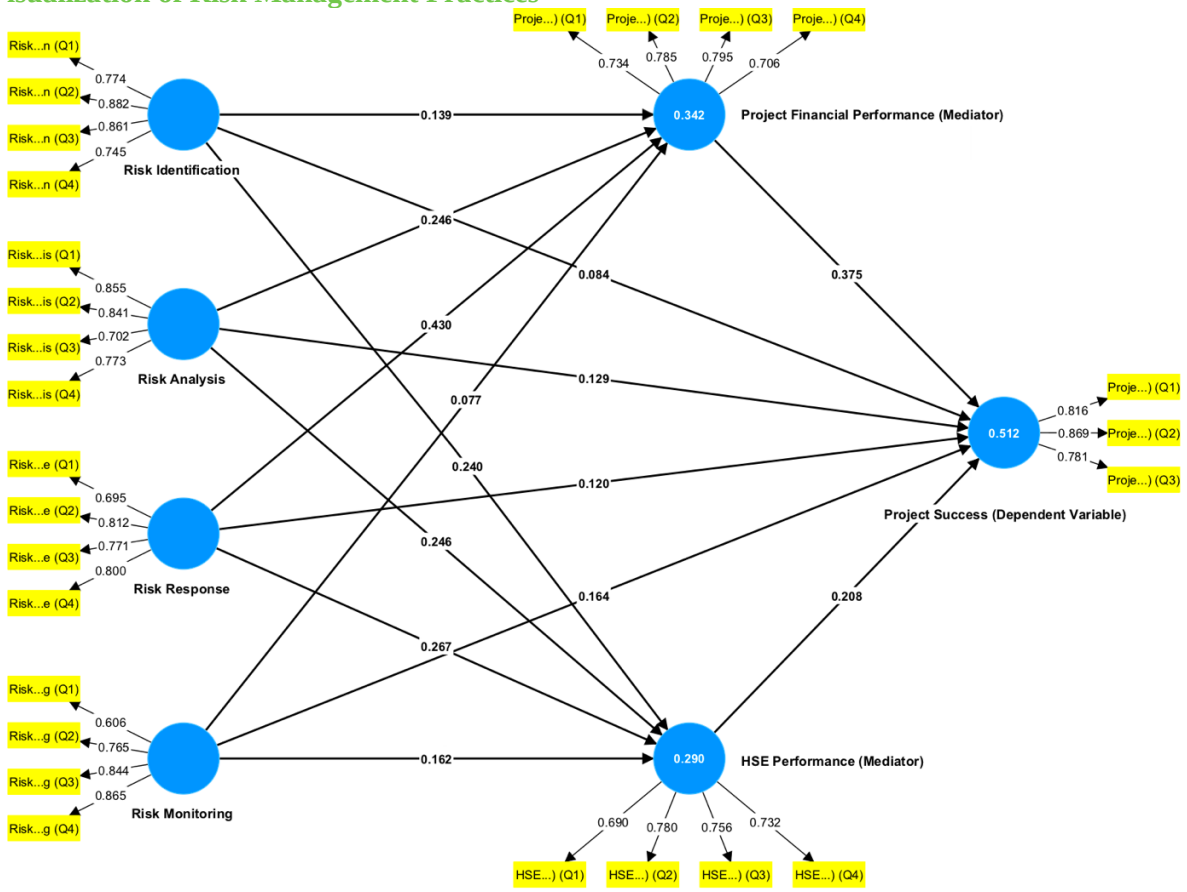

Figure 7. PLS SEM Model of Risk Management Practices

The graphical model, depicted in Figure 7, provides a holistic view of how risk management practices interact with mediator variables and project success.

Assessment of Path Coefficients

In order to authenticate the proposed connections between risk management approaches, mediating variables, and the dependent outcome of Project Success, a bootstrapping method was applied. The table below delineates the calculated path coefficients and their levels of statistical significance.

Table 9. Bootstrapping Path Coefficients and Significance Levels

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
HSE Performance (Mediator) -> Project Success (Dependent Variable)	0.208	0.202	0.06	3.464	0.000
Project Financial Performance (Mediator) -> Project Success (Dependent Variable)	0.375	0.375	0.059	6.371	0.000
Risk Analysis -> HSE Performance (Mediator)	0.246	0.247	0.059	4.191	0.000
Risk Analysis -> Project Financial Performance (Mediator)	0.246	0.247	0.05	4.917	0.000
Risk Analysis -> Project Success (Dependent Variable)	0.129	0.131	0.047	2.780	0.003
Risk Identification -> HSE Performance (Mediator)	0.240	0.238	0.052	4.620	0.000

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Risk Identification -> Project Financial Performance (Mediator)	0.139	0.137	0.049	2.821	0.002
Risk Identification -> Project Success (Dependent Variable)	0.084	0.084	0.044	1.904	0.028
Risk Monitoring -> HSE Performance (Mediator)	0.162	0.166	0.043	3.764	0.000
Risk Monitoring -> Project Financial Performance (Mediator)	0.077	0.081	0.044	1.771	0.038
Risk Monitoring -> Project Success (Dependent Variable)	0.164	0.165	0.038	4.375	0.000
Risk Response -> HSE Performance (Mediator)	0.267	0.265	0.046	5.835	0.000
Risk Response -> Project Financial Performance (Mediator)	0.430	0.429	0.041	10.575	0.000
Risk Response -> Project Success (Dependent Variable)	0.120	0.119	0.048	2.481	0.007

HSE Performance to Project Success: The noteworthy path coefficient of 0.208 ($p < 0.001$) underscores the pivotal role that HSE management assumes in effecting Project Success.
Project Financial Performance to Project Success: With a substantial coefficient of 0.375 ($p < 0.001$), this pathway reveals that proficient financial management is indispensable for achieving the targeted project outcomes.
Risk Management Practices: The coefficients manifest that diverse risk management protocols such as Risk Analysis, Risk Identification, Risk Monitoring, and Risk Response have multifaceted impacts on HSE Performance, Project Financial Performance, and overall Project Success.

Evaluation of Total Indirect Effects

This subsection elaborates the mediational role played by HSE Performance and Project Financial Performance in the relationship between risk management activities and Project Success.

Table 10. Bootstrapping Total Indirect Effects and Significance Levels

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Risk Analysis -> Project Success (Dependent Variable)	0.143	0.142	0.030	4.737	0.000
Risk Identification -> Project Success (Dependent Variable)	0.102	0.1	0.029	3.454	0.000
Risk Monitoring -> Project Success (Dependent Variable)	0.063	0.064	0.023	2.77	0.003
Risk Response -> Project Success (Dependent Variable)	0.217	0.215	0.034	6.439	0.000

Risk Analysis to Project Success: The notable indirect coefficient of 0.143 ($p < 0.001$) suggests that Risk Analysis exerts influence not only directly on Project Success but also mediates its effects through other performance metrics.
Risk Identification to Project Success: A coefficient of 0.102 ($p < 0.001$) elucidates that Risk Identification indirectly influences Project Success via mediating variables like HSE and Financial Performance.

Risk Monitoring to Project Success: The indirect effect coefficient of 0.063 (p = 0.003) insinuates the significance of ongoing monitoring activities and its consequent reverberations on the project's overall success.

Risk Response to Project Success: A robust coefficient of 0.217 (p < 0.001) accentuates that Risk Response not only has a direct effect but also leverages other performance variables to contribute to Project Success.

The calculated total indirect effects augment our comprehension of the intricate web of relationships that characterize the model. It offers a holistic understanding of how risk management protocols interplay with performance metrics, thereby influencing the success of construction projects in Myanmar.

Examination of Specific Indirect Effects

In this section, the focus is on dissecting the specific indirect effects, underscoring how risk management practices indirectly contribute to Project Success via various mediators. This nuanced analysis delineates the unique mediating routes connecting the variables.

Table 11. Bootstrapping Specific Indirect Effects and Significance Levels

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Risk Response -> HSE Performance (Mediator) -> Project Success (Dependent Variable)	0.055	0.054	0.019	2.892	0.002
Risk Response -> Project Financial Performance (Mediator) -> Project Success (Dependent Variable)	0.161	0.161	0.031	5.169	0.000
Risk Identification -> Project Financial Performance (Mediator) -> Project Success (Dependent Variable)	0.052	0.051	0.02	2.576	0.005
Risk Monitoring -> HSE Performance (Mediator) -> Project Success (Dependent Variable)	0.034	0.034	0.015	2.297	0.011
Risk Analysis -> Project Financial Performance (Mediator) -> Project Success (Dependent Variable)	0.092	0.092	0.023	4.012	0.000
Risk Monitoring -> Project Financial Performance (Mediator) -> Project Success (Dependent Variable)	0.029	0.03	0.017	1.711	0.044
Risk Analysis -> HSE Performance (Mediator) -> Project Success (Dependent Variable)	0.051	0.05	0.019	2.707	0.003
Risk Identification -> HSE Performance (Mediator) -> Project Success (Dependent Variable)	0.05	0.049	0.02	2.511	0.006

The study identified significant indirect effects between risk management practices and project success, mediated by Financial and HSE Performance. Notably, Risk Response had a strong impact on both Project Financial (p < 0.001) and HSE Performance (p = 0.002), influencing project success. Risk Identification and Risk Monitoring were also key, affecting financial outcomes (p = 0.005, p = 0.044 respectively) and HSE metrics (p = 0.006, p = 0.011 respectively). Risk Analysis contributed substantially to both Financial (p < 0.001) and HSE (p = 0.003) Performance. These results highlight the vital role of risk management and its intermediary variables in determining the success of construction projects in Myanmar.

Total Effects Analysis

This analysis aims to provide a holistic view of how different aspects of risk management, coupled with mediators, collectively impact Project Success.

Table 12. Bootstrapping Total Effects and Significance Levels

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
HSE Performance (Mediator) -> Project Success (Dependent Variable)	0.208	0.202	0.06	3.464	0.000
Project Financial Performance (Mediator) -> Project Success (Dependent Variable)	0.375	0.375	0.059	6.371	0.000
Risk Analysis -> HSE Performance (Mediator)	0.246	0.247	0.059	4.191	0.000
Risk Analysis -> Project Financial Performance (Mediator)	0.246	0.247	0.05	4.917	0.000
Risk Analysis -> Project Success (Dependent Variable)	0.273	0.273	0.054	5.043	0.000
Risk Identification -> HSE Performance (Mediator)	0.24	0.238	0.052	4.62	0.000
Risk Identification -> Project Financial Performance (Mediator)	0.139	0.137	0.049	2.821	0.002
Risk Identification -> Project Success (Dependent Variable)	0.186	0.184	0.053	3.53	0.000
Risk Monitoring -> HSE Performance (Mediator)	0.162	0.166	0.043	3.764	0.000
Risk Monitoring -> Project Financial Performance (Mediator)	0.077	0.081	0.044	1.771	0.038
Risk Monitoring -> Project Success (Dependent Variable)	0.227	0.229	0.044	5.146	0.000
Risk Response -> HSE Performance (Mediator)	0.267	0.265	0.046	5.835	0.000
Risk Response -> Project Financial Performance (Mediator)	0.43	0.429	0.041	10.575	0.000
Risk Response -> Project Success (Dependent Variable)	0.337	0.334	0.043	7.913	0.000

The study identifies significant total effects of various risk management practices and performance measures on Project Success. HSE Performance ($p < 0.001$) and Project Financial Performance ($p < 0.001$) stand as critical contributors. Risk Analysis, Risk Identification, Risk Monitoring, and Risk Response also exhibit pervasive impacts across HSE and Financial Performance, as well as Project Success, all with p-values below 0.05. This analysis underscores the intertwined nature of risk management practices, performance metrics, and project outcomes. The results offer practitioners a holistic understanding of influential variables, facilitating more effective risk management strategies in the construction industry.

Outer Loading Analysis

This section is dedicated to evaluating how well observed indicators are loaded onto their respective latent variables, which is critical for confirming the model's convergent validity.

Table 13. Outer Loading Results and Significance Levels

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
HSE Performance (Mediator) (Q1) <- HSE Performance (Mediator)	0.69	0.687	0.041	16.951	0.000
HSE Performance (Mediator) (Q2) <- HSE Performance (Mediator)	0.78	0.78	0.023	34.301	0.000
HSE Performance (Mediator) (Q3) <- HSE Performance (Mediator)	0.756	0.753	0.038	19.784	0.000
HSE Performance (Mediator) (Q4) <- HSE Performance (Mediator)	0.732	0.729	0.037	19.859	0.000
Project Financial Performance (Mediator) (Q1) <- Project Financial Performance (Mediator)	0.734	0.734	0.027	27.085	0.000
Project Financial Performance (Mediator) (Q2) <- Project Financial Performance (Mediator)	0.785	0.784	0.028	28.328	0.000
Project Financial Performance (Mediator) (Q3) <- Project Financial Performance (Mediator)	0.795	0.793	0.028	27.959	0.000
Project Financial Performance (Mediator) (Q4) <- Project Financial Performance (Mediator)	0.706	0.703	0.045	15.664	0.000
Project Success (Dependent Variable) (Q1) <- Project Success (Dependent Variable)	0.816	0.815	0.022	37.625	0.000
Project Success (Dependent Variable) (Q2) <- Project Success (Dependent Variable)	0.869	0.869	0.015	57.351	0.000
Project Success (Dependent Variable) (Q3) <- Project Success (Dependent Variable)	0.781	0.779	0.034	22.753	0.000
Risk Analysis (Q1) <- Risk Analysis	0.855	0.853	0.019	44.809	0.000
Risk Analysis (Q2) <- Risk Analysis	0.841	0.841	0.02	42.858	0.000
Risk Analysis (Q3) <- Risk Analysis	0.702	0.697	0.042	16.892	0.000
Risk Analysis (Q4) <- Risk Analysis	0.773	0.771	0.036	21.639	0.000
Risk Identification (Q1) <- Risk Identification	0.774	0.771	0.033	23.479	0.000
Risk Identification (Q2) <- Risk Identification	0.882	0.882	0.016	54.336	0.000
Risk Identification (Q3) <- Risk Identification	0.861	0.86	0.019	46.434	0.000
Risk Identification (Q4) <- Risk Identification	0.745	0.741	0.044	17.113	0.000
Risk Monitoring (Q1) <- Risk Monitoring	0.606	0.601	0.078	7.727	0.000
Risk Monitoring (Q2) <- Risk Monitoring	0.765	0.759	0.052	14.583	0.000
Risk Monitoring (Q3) <- Risk Monitoring	0.844	0.837	0.036	23.534	0.000

	Original sample (O)	Sample mean (M)	Standard deviation (STDEV)	T statistics (|O/STDEV|)	P values
Risk Monitoring (Q4) <- Risk Monitoring	0.865	0.861	0.033	26.226	0.000
Risk Response (Q1) <- Risk Response	0.695	0.693	0.038	18.272	0.000
Risk Response (Q2) <- Risk Response	0.812	0.811	0.022	36.31	0.000
Risk Response (Q3) <- Risk Response	0.771	0.771	0.029	26.971	0.000
Risk Response (Q4) <- Risk Response	0.8	0.799	0.021	37.887	0.000

The study reveals high external loadings across all constructs, affirming their strong association with their respective indicators (all $p < 0.001$). HSE and Financial Performance exhibit loadings between 0.69-0.795, while Project Success ranges from 0.781-0.869. Similarly, Risk Analysis, Identification, Monitoring, and Response constructs show strong relationships with their indicators, all exceeding loadings of 0.6. However, Risk Monitoring (Q1) registers a slightly lower loading of 0.606, meriting further scrutiny. These findings support the reliability and validity of the measurement model, setting the stage for subsequent structural model analyses.

Bootstrapping Graphical Output

For a concise visual summary of the relationships between risk management practices, financial performance, HSE performance, and project success, see Figure 8. This figure, inserted below, features path coefficients and p-values from bootstrapping. Notably, paths with p-values less than 0.05 should be the focus for informed decision-making. This graphical output serves as a critical introduction to the ensuing discussion section and underlines key statistical insights.

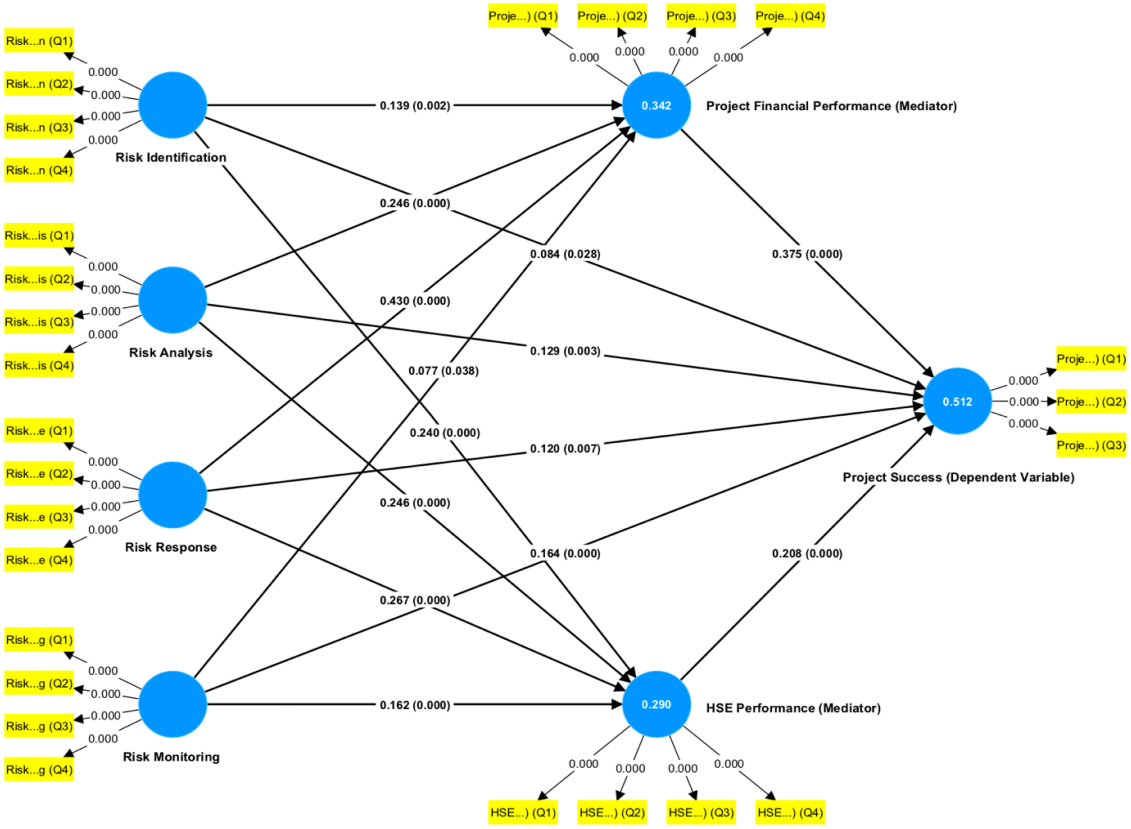

Figure 8: Bootstrapped Graphical Model of Risk Management Practices, Financial Performance, HSE Performance, and Project Success

The research findings provide compelling evidence to demonstrate the crucial importance of risk management systems in the successful completion of building projects in Myanmar. All hypotheses and their corresponding sub-hypotheses were determined to be supported, thereby offering a thorough comprehension of the impact of risk management on the attainment of project objectives.

Effective Risk Identification: The significant correlation between risk identification and project success should not be underestimated. The prompt and precise identification of risks facilitates the timely deployment of preventive or mitigative measures. Neglecting this stage might have severe repercussions, including potential delays, increased costs, or even complete project failure.

Thorough Risk Analysis: The correlation between risk analysis and project success is of considerable importance, as it underscores the necessity of comprehending the intricacy, likelihood, and potential consequences associated with each detected risk. Inadequate risk analysis can result in compromised decision-making processes, wherein risks with significant consequences are not adequately mitigated, while risks with minimal impact demand excessive resources.

Tailored Risk Response Strategies: The high statistical significance between well-implemented risk response strategies and project success points to the fact that a "one-size-fits-all" approach to risk management is ineffective. Customized, project-specific risk responses are not merely good practice; they're essential for project success.

Continuous Risk Monitoring: The positive relationship between regular monitoring and project success shows that risk management is not a "set it and forget it" task. Risks evolve over the life of the project, and ongoing monitoring ensures that the risk management strategies adapt accordingly.

Moreover, the study goes beyond traditional risk management practices to examine the mediating roles of Financial and HSE performance. The findings suggest that the correlation between different risk management approaches and project success is mediated by financial performance, indicating that the effectiveness of risk management is closely tied to efficient financial management.

Financial Performance: Risk identification and analysis directly influence financial planning. Risks related to budget overruns or delays can be significant cost centers, and thus, early identification and thorough analysis help in sound financial management.

Health, Safety, and Environmental (HSE) Performance: The findings of the study indicate that the performance of HSE plays a crucial role in mediating the connection between risk management and the achievement of project objectives. In an industry where health and safety are often at risk, this is a critical finding. Effective risk management practices not only make projects more successful but also safer and more sustainable.

In essence, the study shows that risk management is a complex, multi-dimensional practice that influences various facets of project success, both directly and indirectly. The mediating roles of financial and HSE performance add another layer to this complexity, highlighting the interconnected nature of risk management in construction projects. This interconnectedness is crucial to understanding how best to approach risk management to optimize for success.

The findings of this study underscore the pivotal role that effective risk management plays in the success of construction projects in Myanmar. As noted, robust risk identification and analysis are foundational to mitigating potential project threats. This aligns with the observations of Kallow et al. (2023), who identified that thorough risk management practices significantly contribute to project success by enhancing risk coping capacity and transparency.

Moreover, the mediating roles of financial and HSE performance are critical. Duc et al. (2024) found that internal controls, a component of financial management, play a mediating role in corporate environmental responsibility, reducing business risks for SMEs. This study's results echo these findings, showing that financial performance not only directly impacts project success but also mediates the effects of risk management practices. Furthermore, the integration of HSE practices into risk management, as highlighted by Salzano et al. (2024), not only ensures compliance with safety standards but also enhances project efficiency and success.

Onubi et al. (2023) further emphasized the connection between health and safety performance and owner satisfaction in construction projects, highlighting the role of pro-environmental practices in enhancing economic performance. Similarly, Zhang et al. (2024) discussed the impact of innovation on competitiveness in construction projects, underscoring the importance of environmental regulation and sustainability as moderating and mediating factors. These insights are crucial for understanding the multifaceted impact of risk management on project success.

Incorporating these references provides a broader context and supports the significance of comprehensive risk management strategies in construction projects, particularly in dynamic environments like Myanmar. Effective risk management, coupled with strong financial and HSE performance, is crucial for overcoming the challenges posed by the construction industry's inherent risks and ensuring sustainable project success.

The results serve as an urgent call to action for industry professionals. Effective risk management is not just a compliance requirement but a critical success factor. The study highlights the significance of each stage in the risk management process, from identification to monitoring, thereby providing a holistic approach to improving project outcomes. Specifically, the financial and HSE metrics offer immediate, actionable insights for better resource allocation and regulatory compliance. This study addresses a significant void in the current body of research by examining a relatively understudied, although highly pertinent, setting—the construction sector in Myanmar. This study offers empirical evidence supporting the significant impact of risk management strategies, financial performance, and HSE metrics on the achievement of project objectives. Hence, this research can establish a fundamental basis for subsequent scholarly investigations into the intricate mechanisms of risk management in developing economies.

While the present investigation provides vital insights, it is crucial to understand the inherent limits associated with it. The study's ability to be applied to other contexts is limited due to its specific focus on Myanmar, thereby limiting its potential for generalizability. The use of self-reported questionnaire data has the potential to introduce response bias. Subsequent investigations could potentially adopt a longitudinal approach in order to examine the evolution of effectiveness in risk management strategies throughout the entirety of construction projects. Moreover, it would be advantageous to investigate the impact of several mediating or moderating variables, such as organizational culture, governance processes, and technical capabilities, in order to obtain a more thorough understanding of project success. In sum, this research study offers substantial insights into the comprehension and use of risk management within the construction industry of Myanmar. This discovery not only validates the importance of risk management in attaining project success, but also underscores the intermediary roles that financial and HSE performance play in this correlation. The aforementioned findings possess substantial significance for professionals seeking to improve project outcomes and for academics striving to broaden the current knowledge base in the domain of construction project management.

CONCLUSION

The present study offers a strong empirical basis to support the significant impact of risk management strategies on the achievement of construction project success in the distinctive socio-economic environment of Myanmar. The research not only validates the direct correlation between effective risk management, which includes activities such as identification, analysis, response, and monitoring, and the achievement of project objectives, but also reveals the substantial mediating influences of both Financial and Health, Safety, and Environmental (HSE) performance. The inclusion of these mediating variables introduces an additional level of intricacy to the risk-success paradigm, underscoring the importance of adopting a comprehensive approach to risk management in building projects.

In academic terms, these findings significantly extend existing literature on project management and risk assessment by focusing on an emerging market, thereby filling an important research void. For practitioners, the research provides an empirically-tested framework for implementing effective risk management strategies. Given Myanmar's growing construction industry and evolving regulatory landscape, these insights are invaluable for project managers, financial analysts, and HSE professionals engaged in project planning and execution.

Furthermore, the study offers a novel contribution by employing Smart PLS (Partial Least Squares) for data analysis, a technique recognized for its efficacy in handling complex models and smaller sample sizes, making it particularly relevant for studies like this one that navigate intricate relationships among multiple variables. Thus, the research is not only a contribution to academic discourse but also serves as a pragmatic guide for industry professionals aiming for project success in volatile, uncertain, complex, and ambiguous (VUCA) environments.

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AUTHOR CONTRIBUTIONS

The authors contribution summarizes as Theingi Aung: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data Curation, Writing - Original Draft, Arkar Htet: Software, Resources, Formal analysis, Data Curation, Sui Reng Liana: Visualization, Supervision, Project administration, Amiya Bhaumik: Supervision, Project administration, Funding acquisition, Sandeep Poddar: Writing - Review & Editing, Funding acquisition.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

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