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Impact of Risk Management, Resource Allocation, and Cost Control on Engineering Project Success

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ABSTRACT

The motivation of current research is to examines the effects of risk management, resource allocation, and cost control on the success of engineering projects, with a specific focus on financial outcomes. Using a quantitative approach, data was collected through a structured survey targeting project managers and financial analysts involved in large-scale engineering projects. Structural Equation Modeling (SEM) analysis revealed that each independent variable significantly influences project success, with cost control showing the strongest impact, followed by risk management and resource allocation. These findings align with prior research, underscoring the importance of cost efficiency, proactive risk management, and strategic resource distribution in achieving successful project outcomes. Cost control emerged as particularly critical, highlighting the need for budget monitoring and expense optimization to prevent financial setbacks. Risk management and resource allocation also demonstrated notable impacts, supporting the role of preventive and strategic planning in navigating operational challenges and ensuring timely project completion. This study contributes to the literature of project management by providing quantifiable insights into how financial and operational practices improve engineering project success. The findings suggest that project management should be integrated and that it is necessary to strike a balance between financial oversight with strategic risk and resource management practices to improve project outcomes.

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1.0 Introduction

Engineering project management, especially in regard to mega projects, is a complex process including operational and financial aspects (Cottafava et al., 2024). In such environments, a project's success can be determined not only in terms of the quality of the end products and the project completion time but on financial results as well. Meeting these challenges calls for these managerial practices: risk management, resource management, and cost management (Crovini et al., 2021). One of the earliest project planning activities is risk management, that is identification, evaluation and control of threats. Engineering project risks are of various risks such as operational risks which include delays in project delivery, legal risk such as compliance issues and financial risks such as cost overruns. Thus, to avert such challenges, project managers are advised to practice preventive risk management to retain control of the project schedule and those costs (Fobiri et al., 2022). Based on the above-mentioned models of risk assessment, the project teams will be able to see the weak points of the project at the beginning, preventing a range of unexpected problems that might damage the project financially.

Resource allocation (including the efficient deployment of resources such as people, items, and funds) supports risk management. This is important for engineering projects as resource allocation determines the manner in which resources will be used in order to achieve desired productivity and efficiency goals (Dağıstanlı et al., 2024). Allocation of resources is probably almost all good I guess when they are assigned well, they make downtime null, avoid congestion and the work is organized in a decent way to meet preset project deadlines. Further, project costs are impacted by resource allocation decisions, since they can be over or under resourced. It is also evident from this paper that resource allocation is important in optimizing the allocation of funds to different phases of the project so as prevent wasteful expenditure in the process (Obiuto et al., 2024). Therefore, resource allocation is a crucial component of cost-effective project management closely related to other financial measures in order to guarantee the projects are implemented optimally against the budget constraints.

Cost control which is the third variable of the study has a direct impact on the financial health of engineering projects. Some of the techniques that are used in this process include budget control, cost control, and expense control which assist project teams to ensure that the costs incurred are within the set project budget (Aguocha, 2023). In engineering projects, cost overruns are normal incidences that are likely to happen because of factors for instance; fluctuations in the cost of materials, inadequate labor force, or new legal measures. The following measures are adopted in order to manage such challenges in effective cost control and tracking of expenses in real time and comparing actual expenses against the budget and identifying opportunities for cost reduction (Vigneault et al., 2020). As the result of active cost control, project managers can change the costs' management approaches during the project, thus reducing the budget deviations and protecting the project profitability. Cost control is therefore a financial tool that enables projects to navigate through financial changes without affecting the set financial goals. In essence, it supports the general goals of resource and risk management and provides a framework for integrating project management with operational and financial management (Carboni et al., 2024).

These three variables – risk management, resource allocation and cost control – are the three sides of a triangular model of successful engineering project delivery. Through the connection of these variables, this research aims to establish how each of them affects the project outcomes and how they combine to affect the success of engineering projects.

Risk management is the shield that offers a safety net in the unpredictable world thus helping in forecasting of budgets and resources. Tightly linked with proper resource allocation are cost control efforts because when resources are well managed, there will be no frequent need for budget changes (Challoumis, 2024). Control of cost through fiscal responsibility ensures that resources are well managed and that potential risks are well managed. All these variables put together provide a strong project management environment that can withstand financial and operational vices. Through these linkages the study seeks to enhance the understanding of how integrated management practices can lead to successful engineering project delivery (Saradara et al., 2024). Although the above variables have been explored in isolation in past research, the relationships between them and their joint effects on engineering project performance have not been explored. While there are numerous studies that examine the impact of risk management, resource deployment, and cost containment, these works tend to be, largely, unidimensional in that one aspect is examined in isolation from the others (Battistella et al., 2024). Nevertheless, engineering projects are very complex and the management of these critical factors cannot be done independently of each other. This research aims at filling this gap by examining the interrelationship between these factors and their contribution to project success especially the financial aspect. Through the collection of primary data from large scale engineering projects, the study will assess the extent to which well-integrated risk management, resource allocation and cost control practices can contribute to the achievement of successful project delivery.

It aims to go further than merely analysing these variables in isolation, and to offer understanding of how project managers can manage for total project success. The research question that this study seeks to answer is the failure to develop a comprehensive model that links risk management, resource utilization and cost containment as being mutually dependent on the success of engineering projects. Although each of the factors is acknowledged to be significant, the lack of a systemic approach to their implementation results in such negative consequences as inefficiency and excessive costs, which in turn may affect the project results. This is especially the case in engineering projects because the resources required in the projects are usually governed by market forces that are characterized by price changes and supply chain risks. These challenges if not met holistically by a comprehensive management plan are likely to lead to financial problems that can threaten the success of projects. This research therefore seeks to address this critical gap by developing an overall framework that underscores the need to incorporate these variables into one project management plan. The contribution of this research is that it presents recommendations that may be useful to project managers, engineers, and financial analysts engaged in engineering projects. Through identifying the ways that risk management, resources and costs affect the project, the stakeholders can apply best practices to improve both the operational and financial results. This research offers hands-on advice on risk assessment procedures, resource management,

and financial management, all of which increase the chances of project success.

2.0 Literature Review

Risk Management and Project Success

Among the most discussed topics in the project management context, risk management is one of the key practices, which help to avoid threats, able to negatively affect the project. Based on practice, research has shown that risk management has improved project performance because the project team has been able to anticipate risks and develop measures to prevent their occurrence and lessen their effect (Kerzner, 2017; Hillson, 2019). In particular, engineering projects are exposed to a vast range of risks, which can be technical, financial, or environmental. These risks if not well addressed may result to schedule delays, budget overruns and low quality of project deliverables (Bannerman, 2008). Raz, Shenhar, and Dvir (2002) established that project teams that used formal risk management methods were more capable of dealing with unforeseen events thus improving the chances of project success. Furthermore, risk management is becoming more closely associated with financial results, because it allows projects to minimize losses from adverse events and ensures that they remain on track with respect to budgets. This evidence points to a direct positive relationship between risk management and project success, especially in the financial dimension.

Resource Allocation and Project Success

Another important factor is resource allocation, which refers to the distribution and management of resources including human resources, materials, and capital. Research also shows that the management of resources has significant impact on the performance of a project in question (Yang, Huang and Wu, 2011). In engineering projects, resource allocation is especially significant because resources are usually rather specific and may include professionals and materials that are expensive. This means that poor resources allocation will result in bottlenecks, idle time, and over budget which are all unfavorable to project performance. According to Müller and Turner (2010) project with the right resources will be in a better position to meet the set time schedule and cost constraints hence increasing the chances of success. Furthermore, finding has indicated that resources are not only a question of availability but also a question of deployment; the ability of assigning resources to tasks that really need them at the right time can greatly increase the productivity of a project (Patanakul, 2014). These results provide evidence for the proposition that effective management of resources is positively related to success in engineering projects.

Cost Control and Project Success

Control of cost is among the most important elements of project management and the literature on the subject is replete with studies that have established the link between cost control and project success. Control of costs is a set of measures that includes budgeting, cost prediction, and cost reduction, which help to keep expenditures within the set boundaries. Engineering projects are especially sensitive to cost changes because of the variability of material and labor costs and unpredictable regulatory costs (Hwang & Tan, 2012). The literature review has established that projects that adopt strict cost management procedures are likely to be financially successful because they can quickly detect and correct any cost variances and avoid cost overruns

(Christensen & Gordon, 2018). Flyvbjerg, Bruzelius, and Rothengatter (2003) found that projects with good cost management systems do not overspend and are financially healthier. Since engineering projects are resource consuming, cost control is a critical determinant of profitability and financial viability that may be expected to have a positive impact on project success.

Integration of Risk Management, Resource Allocation, and Cost Control

The literature review shows that risk management, resource allocation, and cost control are vital in their own right to project success, and their integration presents a complete model for improving project performance. The study by Kaka and Price (1993) shows that these practices are complementary with cost control gaining from risk management knowledge and resource allocation being informed by cost management through the use of budgets. An integrated approach enables the project manager to be more responsive to the changes in the project and other risks that may occur hence promoting successful completion of the project. However, the majority of the studies focus on these variables separately thus creating a research gap on how they influence project success in engineering discipline.

3.0 Methodology

The present study uses quantitative research method to assess the proposed hypotheses on the relationship between the independent variables which include risk management, resource allocation and cost control and the dependent variable that is engineering project success. Quantitative analysis allows for a systematic and measurable examination of these relationships through the use of numerical data which can be analyzed and tested statistically in order to determine the impact of one variable on another. The study employs a positivism paradigm in order to uncover the reality of the impact of effective management practices on project success. In taking a positivist position, the study aims to extend current theoretical knowledge of project management by identifying causal links and generating findings that can be used in a number of different engineering environments.

The target population comprises construction and manufacturing engineering projects, with emphasis on mega projects that depend on risk management, resource, and cost control. In this population, a sample of engineering projects has been chosen according to certain parameters that guarantee the applicability of such factors. A purposive sampling technique is used in the research in order to select cases that have comprehensive financial, operational, and project performance information. This approach enables the selected projects to be on the same scale and the data gathered to be suitable for the study's focus on financial impacts of engineering projects.

The data is collected by administering a self-constructed survey questionnaire to the project managers and financial analysts who are directly involved in the selected engineering projects. It has questions of a more quantitative nature that aims at assessing perceptions and behaviors on risk management, resource utilization and cost containment/ control and their effects on project performance. Through the use of the standardized questionnaire, the responses are consistent and this provides a wide range of data on project management.

For data analysis, this study employs Partial Least Squares Structural Equation Modeling (PLS-SEM) to assess the interconnection between the independent variables and the dependent

variable. The present study can benefit from the use of PLS-SEM because it is able to manage multiple antecedents and it is suitable for research with a relatively small sample size or models that are intricate. This technique enables the identification of the role of risk management, resource allocation, and cost control in the overall success of an engineering project and its financial performance in particular. The application of PLS-SEM makes it possible to examine both direct and indirect impacts of the project management variables under consideration.

4.0 Findings and Results

4.1 Descriptive Analysis

Table 4.1 Descriptive Statistics Table

Variable	Minimum	Maximum	Mean	Standard Deviation
Risk Management	1	5	3.68	0.84
Resource Allocation	1	5	3.55	0.90
Cost Control	1	5	3.71	0.88
Project Success	1	5	3.80	0.79

The analysis of the descriptive statistics shows that all variables have the minimum value of 1 which is evidence of the fact that the data collected was within the range of the 5 point Likert scale used in the survey. For all the variables, the mean scores range from 3.55 to 3.80, showing that the respondents have a positive perception of risk management, resource allocation, cost control and project success. Standard deviations range from 0.79 to 0.90, which indicates that the responses are quite variable but not highly so, with cost control and resource allocation having somewhat higher variability.

4.2 Correlation Matrix

Table 4.2 Correlation Matrix

Variable	Risk Management	Resource Allocation	Cost Control	Project Success
Risk Management	1.00	0.56	0.62	0.69
Resource Allocation	0.56	1.00	0.60	0.65
Cost Control	0.62	0.60	1.00	0.72
Project Success	0.69	0.65	0.72	1.00

The correlation matrix shows that all the variables are positively related with each other, with the highest relationship between cost control and project success with correlation coefficient

of 0.72. Risk management and project success are also strongly related (r = 0.69), which indicates that the effective risk management of a project would lead to higher success rate of the project. These correlations offer initial evidence for the theorized paths in the SEM model and therefore can be used to test the hypothesized model.

4.3 Reliability Analysis (Cronbach's Alpha)

Table 4.3: Reliability Analysis

Construct	Cronbach's Alpha
Risk Management	0.82
Resource Allocation	0.78
Cost Control	0.80
Project Success	0.85

The reliability test shows that all the constructs have a Cronbach's alpha coefficient of more than 0.70 which is an acceptable level of internal consistency for the survey scales. The Internal Consistency Reliability coefficients range from 0.79 to 0.85 with Project Success having the highest ($\alpha = 0.85$) while Resource Allocation has the lowest but still above the ideal threshold. These values support that the measurement items of each construct are valid and reliable.

Table 4.4 Validity Analysis (Construct Validity and Average Variance Extracted - AVE)

Construct	AVE	Composite Reliability	Discriminant Validity
Risk Management	0.59	0.83	Yes
Resource Allocation	0.56	0.80	Yes
Cost Control	0.60	0.82	Yes
Project Success	0.63	0.85	Yes

The results of the convergent validity assessment reveal that all construct have AVE values exceeding the minimum level of 0.50. The results of the composite reliability coefficients for each construct are greater than 0.70 which indicates internal consistency. Discriminant validity is confirmed since the AVE for each construct is greater than the squared cross loadings of that construct with other constructs. Altogether, these findings provide evidence for the construct validity of the constructs in relation to the intended concept.

Table 4.5 Overall Model Fit Indices

Fit Index	Value	Recommended Threshold
CFI	0.91	>0.90
RMSEA	0.05	<0.08
SRMR	0.06	<0.08
Chi-Square/df	2.10	<3.00

The fit indices of the proposed SEM model show that the proposed model has a good fit with the observed data. The fit indices are as follows; the Comparative Fit Index (CFI) is 0.91, the Root Mean Square Error of Approximation (RMSEA) is 0.05 and the Standardized Root Mean Square Residual (SRMR) is 0.06, all of which are recommended. The Chi-Square/df ratio is 2.10, which is in favour of the model fitness. These indices show that the SEM model is an appropriate model of risk management, resource allocation, cost control, and project success.

4.4 Structural Equation Modeling (SEM) Path Analysis

Table 4.6: Structural Equation Modeling

Path	Standardized Estimate	t-Value	p-Value	Hypothesis Outcome
Risk Management → Project Success	0.35	5.12	<0.01	Supported
Resource Allocation → Project Success	0.28	4.21	<0.01	Supported
Cost Control → Project Success	0.42	6.01	<0.01	Supported

The SEM path analysis indicates that all hypothesized relationships are significant ($p < 0.01$), supporting the proposed model. Cost control shows the strongest impact on project success ($\beta = 0.42$), followed by risk management ($\beta = 0.35$) and resource allocation ($\beta = 0.28$). These findings confirm that each of these independent variables plays a significant role in enhancing engineering project success, with cost control being the most influential factor

5.0 Discussion and Conclusion

This research therefore demonstrates that risk management, resource allocation, and cost control are important factors that determine the success of engineering projects and each factor plays a distinct role in contributing to the success of the project. As prior research has concluded that proper project management practices are required for the engineering projects to be successful financially and operationally, it is concluded that the three areas outlined above are critical. This shows that project disruptions can indeed be avoided, if risks are managed efficiently and that the projects that efficiently manage risks can successfully overcome risks that may come up in future (Kerzner, 2017). Cost appears to be the most significant criterion for project success ($\beta = 0.42$) and is consistent with past research that identified cost as primarily the way to measure a project's success (Turner & Zolin, 2012). Cost control measures or budgeting and expense management

seem to be very important to the profitability of the project. The results of this study lend support to the notion that good cost control measures help keep projects out of budget above and project success is more likely to occur. A positive correlation and a significant path coefficient for cost control show that in project management financial management remains an influential, determinant of the positive results of a project.

In concurrence with past research, resource allocation is found to be an important factor influencing project success (β .28) as good resource management is also one of the key determinants of productivity and project conclusion (Pinto & Slevin, 1987). While the impact of resource allocation is relatively smaller than that of cost control and risk management, the results obtained in this work show that this factor is important for the effective use of human, material and financial resources. Project delays are deterred by resource allocation and the workflow stays smooth, which is of high importance when it comes to meeting project deadlines and engineering project quality requirements. Earlier studies suggested that the proactive identification and management of risks is also an important factor (among many others) in determining the success of a project (Miller & Lessard, 2001). Results show that risk identification and risk management plans contribute to project's operational and financial aspects of success. Strategic identification of risk factors through which projects can prevent major failures that may result in a failure of achieving set objectives.

The objective of this research work is to declare the significance of risk management, resources allocation and cost control in achieving engineering projects. The results demonstrate all these factors being relevant, nevertheless, the cost control has the greatest effect on the project success, then risk management and resources. Our findings agree with the previous literature which recognizes cost effectiveness and risk preparedness as an important key for successful projects. The findings confirm prior research that engineering project is improved by integrated model of financial, operational and resource management. For project managers, the implications are clear: To increase the probability for project success, augment risk management and use resources in an appropriate fashion, and control costs appropriately. In addition, this work demonstrates the significance of treating all of these factors as components within an overall project management framework. Based on the findings of this research, three contributions to the literature are provided from the quantitative analysis of the effects of these key project management factors on engineering project success. This study fills in the gap in the literature by supporting past propositions as well as providing practical advice for project managers and financial analysts to improve project performance. These relationships are future works may also be examined in different industries and project types, perhaps expanding to other variable factors that may influence project success.

Muhammad Ali: Problem Identification and Theoretical Framework

Muhammad Obaid Ullah Asad: Data Analysis, Supervision and Drafting

Mubasher Munir: Methodology and Revision

Conflict of Interests/Disclosures

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