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Development of Risk Management Model for Research and Development Facilities Construction Project in Johor, Malaysia

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Abstract

The construction industry drives economic growth globally but faces challenges namely outdated practices and inadequate risk management. This research focuses on improving Risk Management in Research and Development (R&D) facilities construction projects, often poorly executed by Project Management Offices (PMOs). Most studies typically address risk identification and assessment, they neglect crucial processes like risk control and monitoring. In pursuit of developing a risk management model for R&D facility construction projects in Johor Industrial Park, Malaysia, conducted a descriptive analysis self-administered questionnaires from professionals in R&D and construction fields with utilizing Statistical Package for the Social Sciences software. Additionally, employed Structural Equation Modelling (illustrated through AMOS graphics) to establish a robust and valid model. The outcome of this research reveals a strong, positive, and significant correlation between PMO requirements of Risk Monitoring and Control Practices, which encompass risk reassessment, risk audits, contingency reserves analysis, risk status meetings and Project Success Factors which related to schedule, cost, facilities requirements, and customer satisfaction in the context of RDD facilities construction. This research successfully tackles the research objectives and developed practicable project risk monitoring and control practices of risk management model for R&D facilities construction projects. Therefore, by consistently integrating these practices into their daily project activities, R&D and construction professionals can mitigate risks and address challenges prevalent in the construction industry, contributing to improved project outcomes.

Keywords: Risk Management, Research and Development, Construction Project, Project Management Office (PMO)

1.0 Introduction

The Malaysian construction sector (MCS) plays a crucial role in the country's economic development, but it faces challenges like project delays, especially in Research and Development (R&D) facilities. R&D is essential for connecting technological advancements to customer value, demanding robust risk management amid uncertainty. Project Management Institute (PMI) guidelines assist consultants and Project Management Office (PMO) practitioners in enhancing project management practices. In Q2 2021, Malaysia's construction sector grew significantly, reaching RM28.2 billion, led by civil engineering and building projects, with the private sector dominating at 53.7%. R&D activities, driven by businesses and universities, are rising, emphasizing the need for R&D facilities to further boost the economy. Effective risk management is crucial to mitigate financial losses and ensure project success. Despite extensive study, practical application of risk management in construction remains limited, risking significant financial losses. Project Management Offices (PMOs) play a vital role in enhancing decision-making clarity through techniques like regular reporting, supporting project managers (Project Management Institute, 2017) and fostering a project management culture.

1.1 Problem Statement

The Construction Industry Development Board (CIDB, 2018) identified key issues causing project delays, such as poor management, low quality and productivity, poor industry image, economic volatility, manpower shortages, and inadequate data. Low productivity in construction is linked to poor project management, low technology use, unskilled labor, high input costs, inaccurate duration estimates, manpower shortages, high waste, poor maintenance, and accident-prone environments. The industry's poor image is due to frequent accidents, job insecurity, poor management, low wages for high-risk jobs, and limited career development opportunities. Ansah et al. (2016) highlighted weaknesses in Malaysia's construction sector, notably in planning and architecture. Although engineering and quantity surveying are established, construction, which handles project implementation, only formalized education recently. This imbalance between planners and implementers hinders growth. Other issues include a poor image, lack of systematic training, inadequate recognition of construction technicians, adversarial consultant-contractor relationships, and poor teamwork.

This study addresses significant losses and delays in R&D facilities construction projects due to inadequate risk management by internal and external PMOs, accounting for up to 85% of project costs (Senesi et al., 2015). Ineffective risk management results from a lack of knowledge, failure to monitor and control risks, and insufficient consideration of risks by project managers (Chapman, 2019). This statistic demonstrates the severity of the issue and result the focus on the level of risk management in the R&D facilities construction sector is unacceptably high and requires attention. Poor risk monitoring can lead to accidents, cost overruns, delays, design errors, equipment failures, labor strikes, low customer satisfaction, poor quality, structural failures, and project failure (Khan & Gul, 2017), impacting organizational performance, reputation, and strategic objectives (Chapman, 2019). While a lack of proper risk management of project risk monitoring and control process in R&D facilities construction projects is known to cause project failure, what remains unknown is how implementing project risk monitoring and control practices impact the level of project success in R&D facilities construction projects across Malaysia.

In view of such scant attention being paid to the implementation of risk management, researchers have instead focused on promoting the adoption and implementation of risk management systems in developing countries (Grigore et al., 2018). To evaluate the success of these systems, the appropriate first step is to identify the critical success factors for Implementation of Risk Management Systems (IRMS) in developing countries. Yet, little information regarding actual risk management implementation systems is available from developing countries (Iqbal et al., 2015). Iqbal stated the existing studies on risk management in developing countries have almost entirely concentrated on identifying and evaluating risks rather than the systems applied.

Despite its importance, the impact of risk monitoring and control on project success in R&D facilities construction in Malaysia is not well understood. Effective risk management, involving clear scope, budget, work breakdown structures, and communication plans with SMART goals, is crucial (Moore et al., 2017). This research aims to develop a risk management model for R&D facilities construction in Johor Industrial Park, Malaysia, providing a knowledge base for managing risks and ensuring project success. The findings will help R&D engineers and PMOs improve risk management, contributing to successful project delivery.

2.0 Literature Review

This chapter provides the outlines of the literature related to risk management of project risk monitoring and control practices correlates with project success in R&D facilities construction in Malaysia. The success of construction projects is crucial for both stakeholders and a country's economic and social development (Sohu, Jhatial, Ullah, Lakhiar, & Shahzaib, 2018). Construction projects create employment and generate income at both the national and local levels. One primary consideration in construction projects is the monitoring and controlling of risks to reduce the possibility of potentially devastating effects of risks on project performance. This chapter reviewed the existing literature relating to the research and the hypotheses for this study. The main concepts or constructs will cover Risk Monitoring and Control Practices, which encompass risk reassessment, risk audits, contingency reserves analysis, risk status meetings and Project Success Factors which related to schedule, cost, facilities requirements, and customer satisfaction in the context of RDD facilities construction project.

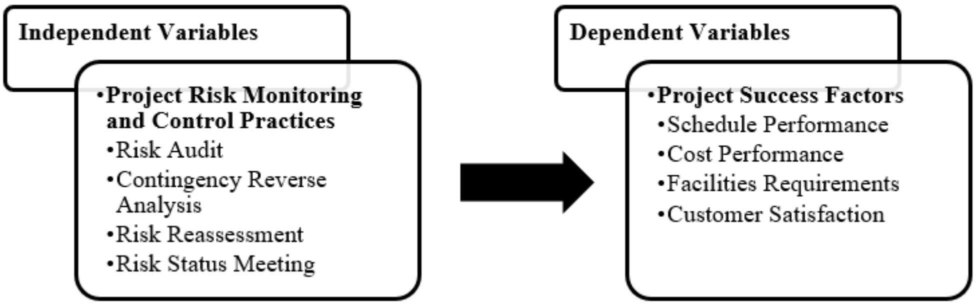
2.1 Theoretical Review

In the contemporary interconnected world, risk is an integral facet of daily existence, notably within the construction sector (Shahzaib, 2018). Risk management entails proactive measures that align actions with potential outcomes. Risks may be categorized as known or unknown, with unknown risks posing challenges in predicting events that could impact project goals (Ahmed, R. et al., 2015). The comprehension of risk involves assessing uncertain events, particularly in construction, where variables such as time, cost, and quality are susceptible (Abdul Rahman. et al., 2015). The construction industry presents unique challenges due to uncertainties stemming from natural phenomena, environmental factors, and organizational structures (Abderisak. et al., 2015). Despite extensive studies addressing global construction challenges, fewer have delved into issues specific to the Malaysian construction sector. This review examines the encountered problems in Malaysian construction through both local and international perspectives. Several authors, such as Abdul Rahman and Alidrisyi (1994), Nima (2001), and Abdul Rahman et al. (2005), have documented these issues. Abdul Rahman et al. (2006) discovered that nearly half of Malaysian projects experienced delays, resulting in financial losses and negative repercussions for the industry and economy. Bredillet (2018) emphasized the urgency of addressing these deficiencies in the new millennium. Moreover, numerous researchers, including Al-Nahj (2012) and Daptiv (2013), suggest categorizing Project Management Office (PMO) functions into supportive, controlling, and directive roles, each crucial for effective project management. PMOs, as defined by the Project Management Institute (PMI, 2017), are organizational units responsible for establishing and maintaining project and program management standards. In today's intricate business landscape, strategic initiatives are imperative for success, yet many projects falter in achieving their objectives. PMOs play a pivotal role in driving strategic change within organizations, striving for successful business outcomes by enhancing execution management practices, organizational governance, and leadership in strategic change. In recent years, the importance of implementing risk management in Research and Development (R&D) industries has gained recognition due to the inherent uncertainties involved (Luppino, 2014). The literature highlights the significance of project risk monitoring and control processes in enhancing risk management efficiency and project success. Effective risk control contributes to reliable financial information, investor confidence, and organizational transparency, while regular risk monitoring enables continuous improvement, stakeholder engagement, and prevention of project failure. Integrating risk monitoring and control practices in R&D facility construction projects is crucial for success, as suggested by existing research.

2.2 Conceptual Framework

The aim of this study is to create a Risk Management model tailored for the construction on R&D facilities. The model is intended to be utilized by R&D partitioners engaged in facility establishment, as well as both internal and external Project Management Office (PMO) professionals in Johor Industrial Park, Malaysia. The success of construction projects is crucial for both stakeholders and a country's economic and social development (Sohu, Jhatial, Ullah, Lakhiar, & Shahzaib, 2018). The research study structured to examine if a correlation exists between the four-risk management of project risk monitoring and control practices, and project success in R&D facilities construction projects. The four-risk management of project risk monitoring and control practice variables included risk reassessment, risk audits, contingency reserves analysis and risk status meeting which acted as the independent variables, while project success act as the dependent variable. Figure.1 presents the conceptual framework for this research.

Figure 1: The Independent Variables and The Dependent Variable Conceptual Framework of The Research



The conceptional framework illustrated in Figure 1 will be testing the hypotheses to determine if a statistically significant relationship existed between the independent variables and the dependent variable.

2.3 Research Gaps

With a limited focus on implementing risk management, researchers are urging the adoption of risk management systems in developing countries. However, there's a scarcity of detailed information on the actual implementation of such systems in these nations, as highlighted by Iqbal et al. in 2017. Majority of studies have concentrated on risk identification, assessment, and analysis, neglecting crucial risk management aspects like control, monitoring, and response. This gap in research leaves unanswered questions about how these processes impact project success, highlighting a significant gap in the literature.

3.0 Materials and Methodology

Non-probability sampling approach was adopted to select the research respondents and chosen from the Johor Industrial Park of Malaysia. The administered questionnaire consisted of the demographic information of the study respondents, coupled with the research questionnaire categorized according to the duties of the stakeholders. The questionnaire was based on 5- point Likert scale, and calibrated thus: 1 = strongly disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree, 5 = strongly agree. Collection of data was done through self-administered questionnaires, but prior to the administration of the questionnaires, validation of academician and construction experts was carried out, resulting in an acceptable Cronbach's alpha values, as indicated hereafter. Also, the inputs of the experts were considerably put into use to enrich the questionnaire. In achieving the purpose of the study, the target population were R&D and construction professionals who involved in R&D facilities construction project. Recent advancements indicate that researchers ought to determine sample size via power analysis. This analysis establishes the minimum sample size considering the component of a model with the greatest number of predictors (Aberson, Hair et al., 2019). It necessitates data on power, effect size, and significance level to compute the minimum required sample size (Hair et al., 2018). Power (1-ß error probability) refers to the "ability of a statistic to accurately reject the null hypothesis when it is false" (Burns & Burns, 2008). An achievement of a value equal to or greater than a certain percentage denotes a satisfactory level of power in social science research (Hair et al., 2018; Hassan, 2019). Effect size measure the magnitude of the effect that individual independent variables have on the dependent variable (Albers, C. J., Lakens, D. 2018). To estimate sample size, it is necessary to know the extent of the effect in order to achieve statistical power of so percent or greater. Correll (2020) suggested that the values of 0.02, 0.15, and 0.35 be interpreted as small, medium, and large effects respectively. The significance level (α) indicates the likelihood of rejecting the null hypothesis. In social and behavioral science studies, a significance level of 0.05 (5%) is commonly accepted (Hair et al., 2017). Several statistical programs able to conduct power analysis, including G*Power, SAS Power, IBM SPSS Sample Power, Solo Power Analysis, Power, and Analysis and Sample Size System (PASS). G*Power is frequently preferred by business and social science researchers (Hair et al., 2017).

In this research, to determine the needed sample size based on specified values for alpha, power, and effect size. With input parameters set for a two-tailed test, a power of 0.95, an effect size of 0.35, and an alpha of 0.05. The G*Power 3.1.9.4 software (Figure. 2) was employed to ascertain the required sample size, resulting in a determination of 59 participants necessary for conducting an analysis that involves a F-test using linear multiple regression (Figure. 3) with a single coefficient (Hair et al., 2019).

Figure 2: F-test With G*Power

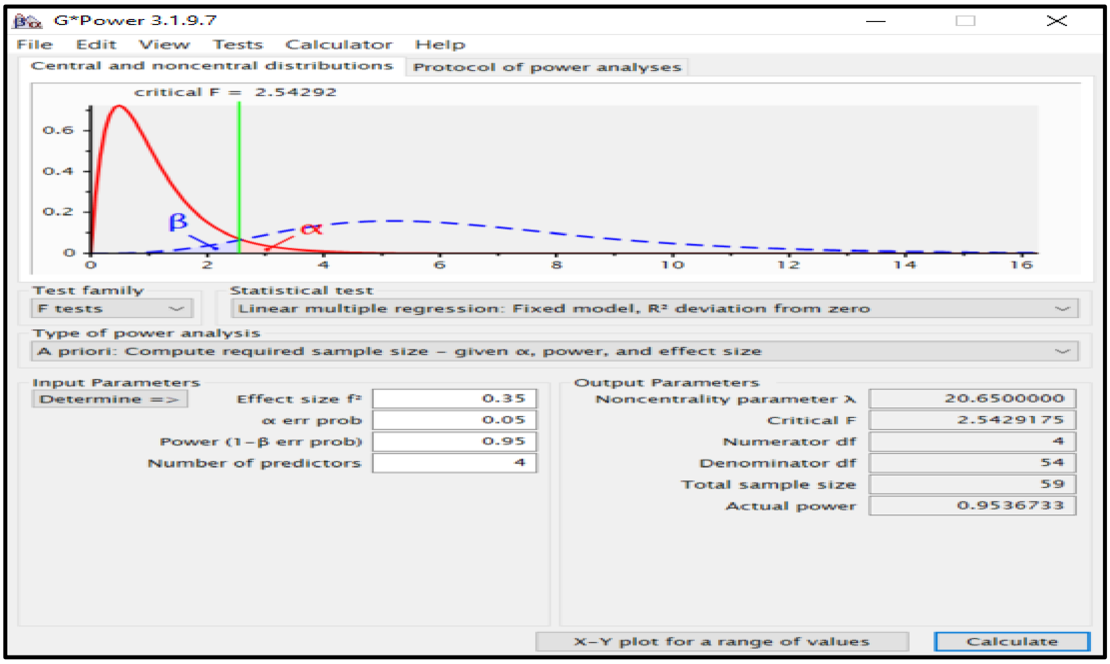
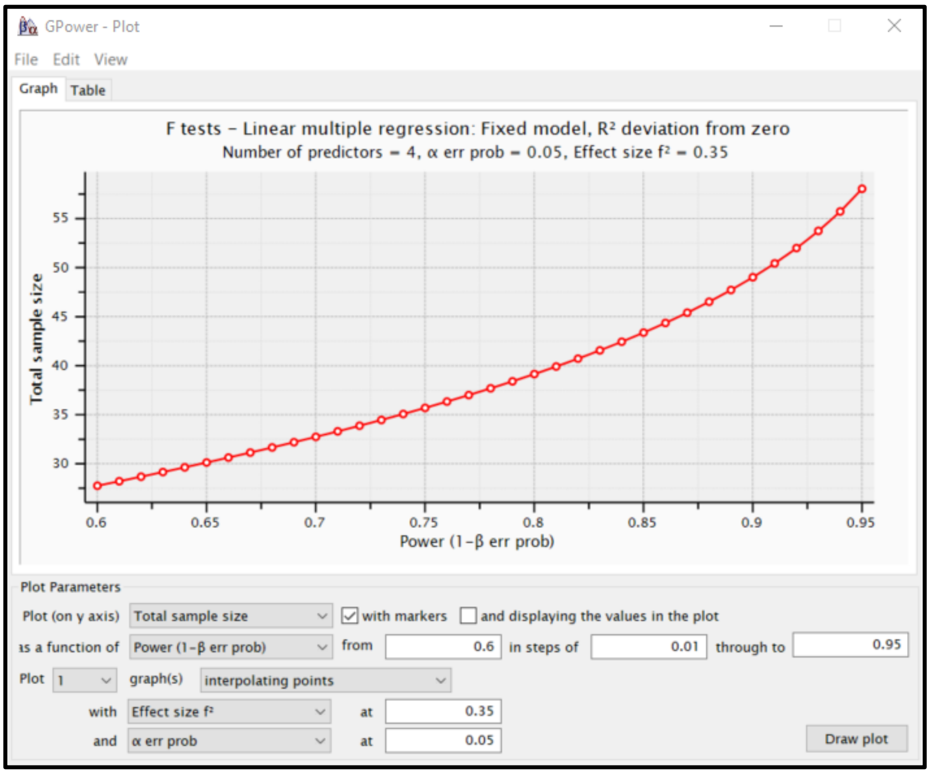


Figure 3: Graph Of Total Sample As A Function Power



The questionnaires were administered through physical contact and e-mails in the Johor Industrial Park of Malaysia, being the scope of the study. The missing data were treated and transferred to the SPSS software. In the analysis, exploratory factor analysis, using the SPSS version 29 software was employed in establishing correlation analysis to address the hypotheses of the research problems (Park & Park, 2016), the structure of the measurement models, classifying the items into five factors, while the Kaiser-Meyer-

Olkin (KMO) as well as the Bartlett's test of sphericity were engaged in confirming the instrument validity by assessing the sample adequacy and multivariate normality of the study variables. Moreover, the structural equation modelling (SEM) further validated the measurement models through the use of AMOS software by establishing satisfactory goodness-of-fit (GFI) indices of the variables of the study.

4.0 Findings

4.1 Demographic Information

The demographic characteristics of the participants in this study are comprehensively detailed in Tables 1 through Table 3. The participants' years of professional experience showed a wide range. Specifically, 18.3% of the respondents had a minimum of 2 years of experience. A more significant portion, 28.3%, had accumulated 3 to 5 years of experience. The largest group, comprising 43.4% of the participants, had between 6 to 10 years of experience. Finally, 10% of the respondents had extensive experience of over 11 years.

In terms of educational qualifications, the participants also exhibited diverse backgrounds. A small fraction, 1.6%, held a Diploma, which typically signifies a shorter post-secondary education. A substantial majority, 61.6%, had completed a Bachelor of Science (BSc) degree, indicating a foundational level of higher education in their field. Additionally, 33.4% of the participants had pursued further studies to obtain a Master of Science (MSc) degree, reflecting advanced knowledge and specialization. A minority, 3.4%, had achieved the highest level of academic qualification, a Doctor of Philosophy (PhD) degree, denoting a significant contribution to research and academic excellence in their discipline.

Table 1: Years of experiences in R&D and construction project managements

Years of Experiences	Frequency (f)	Percentage (%)
Minimum 2 years	11	18.3
3 – 5 years	17	28.3
6 – 10 years	26	43.4
11 years and above	6	10.0
Total	60	100

Table 2: Academic Qualification construction project management

Credential	Frequency (f)	Percentage (%)
Diploma	1	1.6
Bachelor's Degree	37	61.6
Master's Degree	20	33.4
Doctorate Degree	2	3.4
Total	60	100

Table 3: Area of specialization

Job Position	Research and Development Professionals				Construction Professionals			
	R&D	R&D	R&D	Position Above	Project	Constructio n Manager	PMO	Position

	Engineer	Senior Engineer	Manager	Manager	Engineer		Manager	Above Manager
Frequency	1	9	10	10	7	4	14	5
Percentage	3.4	30.0	33.3	33.3	23.4	13.3	46.7	16.6
Total	30 respondents				30 respondents			

Regarding their professional roles, those specializing in Research and Development (R&D) included R&D Engineers (3.4%), R&D Senior Engineers (30%), R&D Managers (33.3%), and individuals at managerial levels above R&D (33.3%). In the construction field, participants held positions such as Project Engineers (23.4%), Construction Managers (13.3%), Project Management Office (PMO) Managers (46.7%), and individuals at managerial levels above construction (16.6%).

4.2 Instrument Reliability

The reliability test results via Cronbach's alpha values demonstrated high levels of internal consistency for each construct: Risk Audit (RA) = 0.974; Risk Reassessment (RR) = 0.972; Contingency Reverse Analysis (CRA) = 0.968; Risk Status Meeting (RSM) = 0.972 and Project Success Factors (PSF) = 0.962 as detailed in Table 4. These values exceed the threshold (0.7) for significance, as specified by Tanko et al. (2018).

Table 4: Reliabilities Statistics

Construct	Code	Cronbach's Alpha
Risk Audit	RA	0.974
Risk Reassessment	RR	0.972
Contingency Reverse Analysis	CRA	9.968
Risk Status Meeting	RSM	0.972
Project Success Factors	PSF	0.962

4.3 Hypothesis Testing

This research endeavour seeks to confirm the relationship between two component variables by conducting a correlation analysis. Specifically, it examines the correlation between risk monitoring and control practices, which encompass risk reassessment, risk audits, contingency reserves analysis, and risk status meetings, in the context of RDD facilities construction which related to project success factors of project schedule, cost, facilities requirements, and customer satisfaction. Before analysing it is important to review the dataset to confirm that the data distributions for related variables (risk reassessment, risk audits, contingency reserves analysis, risk status meetings, and project success factors) followed normality and linearity assumptions. The kurtosis statistics presented in Figure. 4 indicated that the normality assumption was not satisfied for the two independent contingency reverse analysis (3.534) and risk reassessment (3.664) variables. As per Coakes & Steed (2009), normality typically requires values to fall within the range of +3 to -3.

Figure 4: Descriptive Statistics

Descriptive Statistics

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Risk_Audit	60	3.9417	.77448	-.935	.309	2.176	.608
Contingency_Reverse_Analysis	60	4.0694	.74932	-1.244	.309	3.534	.608
Risk_Status_Meeting	60	3.9500	.77733	-.905	.309	2.243	.608
Risk_Reassessment	60	4.0700	.74272	-1.252	.309	3.664	.608
Project_Success_Factors	60	3.9583	.75936	-.388	.309	-.422	.608
Valid N (listwise)	60						

Since the normal distribution assumption was not met, this study opted for a non-parametric Spearman's rho correlational analysis instead of the traditional Pearson's correlation. Spearman's rho correlational analysis was performed to test for significant associations between the independent and dependent variables. Statistical significance was assumed at an alpha value of .05, and the correlation analyses were interpreted and reported using a correlation matrix. Spearman's correlation interpretation is similar to Pearson, e.g., the closer r is to ±1 the stronger the linear relationship. Correlation indicates how strongly variables are related. Its strength is described using terms and values: very weak (.00-.19), weak (.20-.39), moderate (.40-.59), strong (.60-.79), and very strong (.80-1.0) (Laerd Statistics, 2018). Correlation shows whether the relationship is positive or negative, with the corresponding strength term (Schober et al., 2018).

Figure 5: Correlation Between Risk Monitoring Control Practices and Project Success Factors

Correlations

			Risk_Audit	Contingency_ Reverse_ Analysis	Risk Status_ Meeting	Risk_ Reassessment	Project_ Success_ Factors
Spearman's rho	Project_ Success_ Factors	Correlation Coefficient	.678**	.513**	.726**	.505**	--
		Sig. (2-tailed)	<.001	<.001	<.001	<.001	.
		N	60	60	60	60	60

**. Correlation is significant at the 0.01 level (2-tailed).

As indicated in Figure. 5, the Spearman's rho Correlation between PMO requirements (Risk Monitoring and Control Practices) and R&D facilities construction projects (Project Success Factor) was found to be Strong Positive Correlation in Risk Audit (0.678), Moderate Positive Correlation in Contingency Reverse Analysis (0.513), Strong Positive Correlation in Risk Status Meeting (0.726), Moderate Positive Correlation in Risk Reassessment (0.505) and statistically significant ($p < .001$). Hence, this shows that increase in Risk Monitoring Control Practices would lead to a higher Project Success Factors. Which means there is a strong positive relationship or high degree of relationship between the two variables (Donal O 'Brien, 2016). Additionally, with hypothesis analysis results, alternative hypothesis supported positive relationship.

4.4 Exploratory Factor Analysis (EFA)

In relation to the factor analysis, KMO is a test conducted (0.779) to examine the strength of the partial correlation (how the factors explain each other) between the variables. KMO values closer to 1.0 are consider ideal while values less than 0.5 are unacceptable. Additionally, the Bartlett's test of sphericity yielded significant results ($p < 0.01$), as indicated in Figure. 6.

Figure 6: KMO And Bartletts Test

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.779
Bartlett's Test of Sphericity	Approx. Chi-Square	2598.945
	df	325
	Sig.	<.001

Figure 7: Rotated Component Matrix

Rotated Factor Matrix[a]

	Factor 1	2	3	4	5
RA1	.787				
RA2	.773				
RA3	.925				
RA4	.920				
RA5	.803				
RA6	.868				
RA7	.849				
RA8	.729				
CRA1		.909			
CRA2		.892			
CRA3		.969			
CRA4		.896			
CRA5		.964			
CRA6		.922			
PSF1			.894		
PSF2			.918		
PSF3			.789		
PSF4			.819		
RSM1				.606	
RSM2				.722	
RSM3				.986	
RSM4				.963	
RSM5				.697	
RR1					.697
RR2					.686
RR3					.778
RR4					.772
RR5					.745

Extraction Method: Maximum Likelihood.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 13 iterations.

Furthermore, the total variance explained, which displayed eigenvalues of 1 and above, was supported by the extraction of the components within the categories. Following the criterion of factor loading of ≥ 0.50 as outlined by Olugbenga (2018), all items were deemed significant and reliable. The items then categorized into five components, as detailed in Figure. 7. Subsequently, based on the results of the factor analysis, five constructs were identified using the varimax rotation method with Kaiser normalization.

4.5 Confirmatory Factor Analysis (CFA)

Confirmatory factor analysis (CFA) serves as a sophisticated multivariate statistical technique employed to evaluate the extent to which the observed variables accurately reflect the underlying constructs posited by a theoretical framework. By scrutinizing the relationships between observed variables and hypothesized constructs, CFA assesses the degree of fit between the observed data and the proposed measurement model. Essentially, it verifies whether the measured variables adequately capture the intended theoretical constructs, thereby validating or invalidating the underlying measurement theory.

In this analysis, the initial step involved constructing a model based on theoretical propositions, particularly drawing from risk monitoring and control practices, which encompass risk reassessment, risk audits, contingency reserves analysis, risk status meetings and project success factors which related to schedule, cost, facilities requirements, and customer satisfaction in the context of RDD facilities construction. The proposed model encapsulated the anticipated relationships between these theoretical constructs. Subsequently, a rigorous examination of model consistency was conducted to assess the alignment between the proposed model and the observed data.

This research has developed a single proposed model set for evaluation, which encompasses four distinct combinations representing the theoretical framework for project success factors within R&D facility construction sites. Confirmatory Factor Analysis (CFA) was then performed on this set of models within the designated framework. This analysis aimed to validate the proposed models by assessing how well they align with the observed data, thereby providing insights into the underlying relationships among the project success factors identified for R&D facility construction sites.

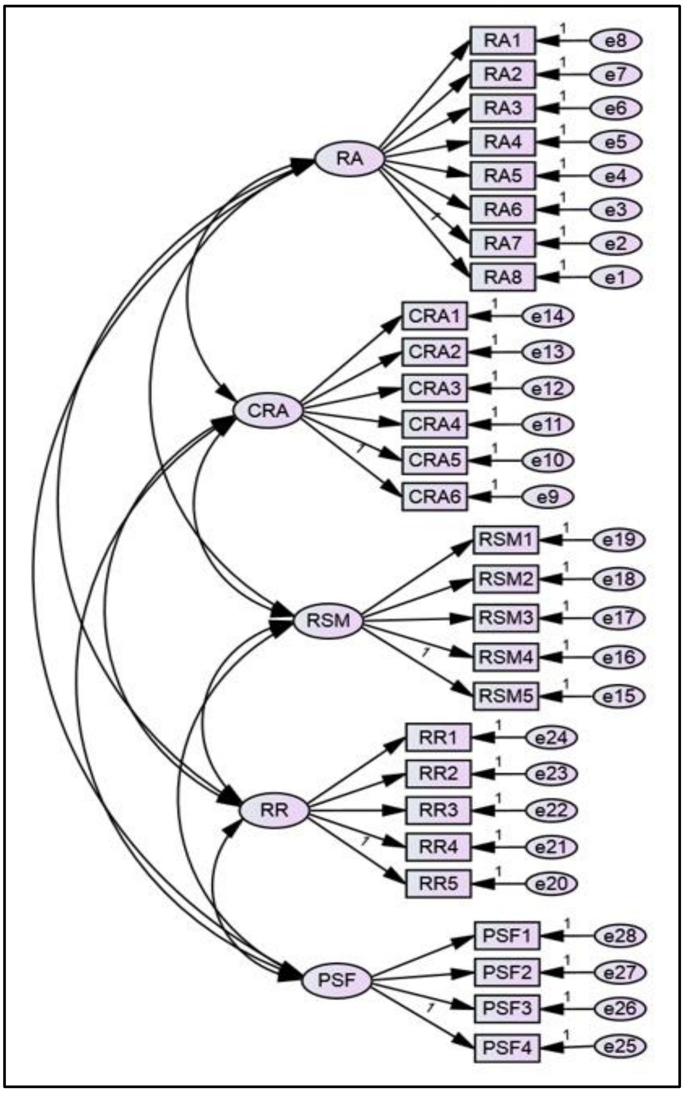
Figure 8: The Concept Model

The concept model in Figure. 8 described project success factors as dependent and risk monitoring and control practices as independent variables.

The subsequent proposed model aims to offer R&D and construction professionals engaged in project management a deeper and more comprehensive comprehension of the advantages and correlations between project risk monitoring and control practices, as well as project success factors. This enhancement aims to elevate the efficacy of Risk Management specifically for R&D facility construction projects in Johor Industrial Park, Malaysia.

The model will describe and serves as a depiction of the interplay between risk monitoring and control practices and project success factors within R&D facility construction sites. This conceptual framework aims to elucidate the relationships between various elements crucial for project success in this specialized context. Figure. 9 portrays the conceptual model and Figure. 10 providing a visual representation of the covaried with the threshold accepted within the key variables involved. This diagram serves as a blueprint for understanding how risk monitoring and control practices impact project success factors within the context of R&D facility construction sites.

Figure 9: Conceptual Model



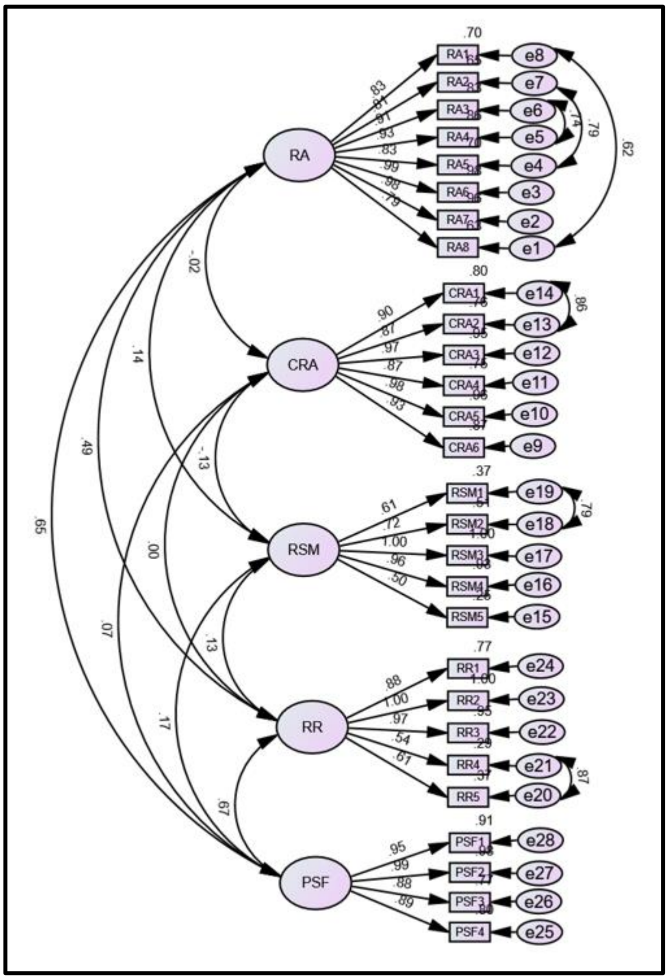


Figure 10: Covaried with Threshold Accepted

Six items were identified with modification indices greater than 20, namely RA1 (e8) to RA8 (e1), RA2 (e7) to RA5 (e4), RA3 (e6) to RA4 (e5), CRA1 (e14) to CRA2 (e13), RSM1 (e19) to RSM2 (e18) and RR4 (e21) to RR5 (e20) as illustrated in Table 5 were covaried.

Table 5: Covariate (Group number 1 – Default model 1)

Estimate Link	M.I.	Par Change
e1 <--> e8	20.563	0.137
e4 <--> e7	31.505	0.139
e5 <--> e6	34.196	0.037
e13 <--> e14	47.829	0.086
e18 <--> e19	36.872	0.133
e20 <--> e21	44.656	0.362

Based on the model validity measures, as detailed in Table 6, there are no validity concerns. The Construct Reliability (CR) values are all greater than 0.7, which confirms that the model is consistently reliable. Additionally, Convergent Validity is established, as the Average Variance Extracted (AVE) values exceed 0.5, and Discriminant Validity bold value greater than the same row and column indicating that the constructs adequately represent the intended theoretical concepts (Olugbenga, 2018).

Table 6: Model Validity measures

	CR	AVE	MSV	MaxR(H)	RA	CRA	RSM	RR	PSF
RA	0.974	0.861	0.346	0.985	**0.928**				
CRA	0.964	0.871	0.008	1.004	-0.012	**0.934**			
RSM	0.902	0.762	0.029	1.078	0.141	-0.091	**0.873**		
RR	0.966	0.904	0.431	1.000	0.433**	0.001	0.161	**0.951**	
PSF	0.960	0.858	0.431	0.991	0.588***	0.072	0.170	0.657***	**0.926**

On the HTMT Table 7. shows no value should greater than 0.9 indicates there are no warnings for this HTMT analysis.

Table 7: HTMT Analysis

	RA	CRA	RSM	RR	PSF
RA					
CRA	0.006				
RSM	0.219	0.145			
RR	0.482	0.023	0.127		
PSF	0.643	0.071	0.207	0.703	

Figure. 11 showcases the structural model, offering insight into how the theoretical constructs are operationalized and Figure. 12 shows the measured through observed variables. This model elucidates the specific indicators used to quantify each latent construct, facilitating a comprehensive assessment of the proposed relationships.

Figure 11: Structural Model

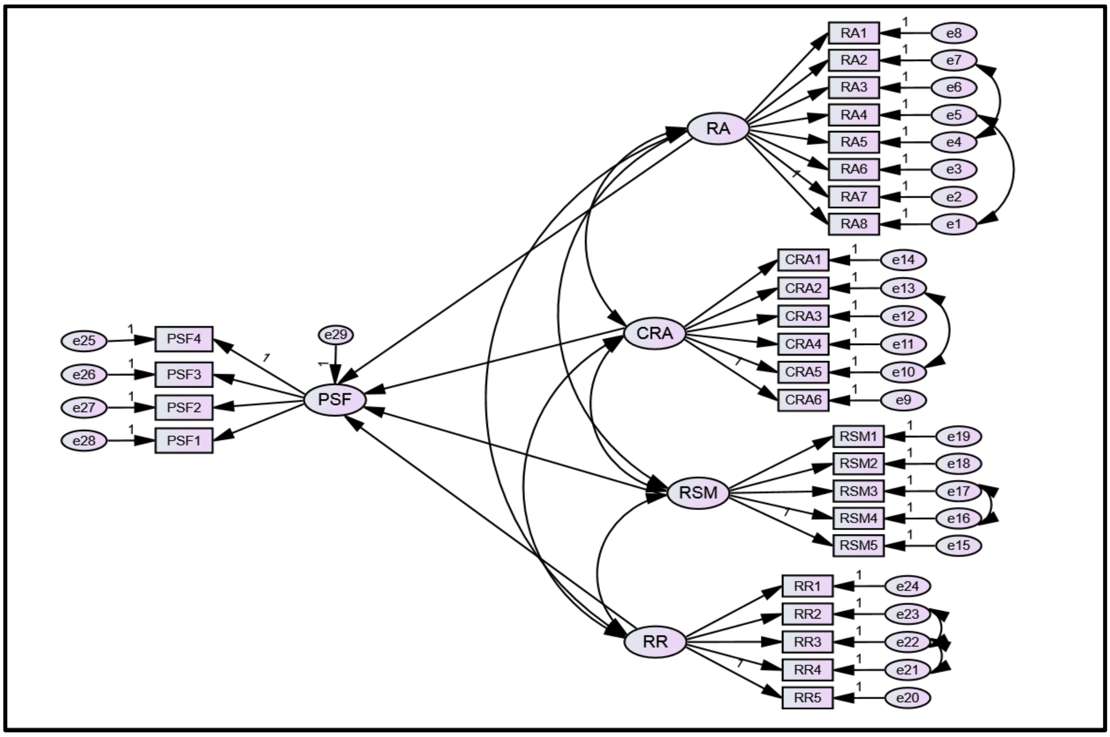
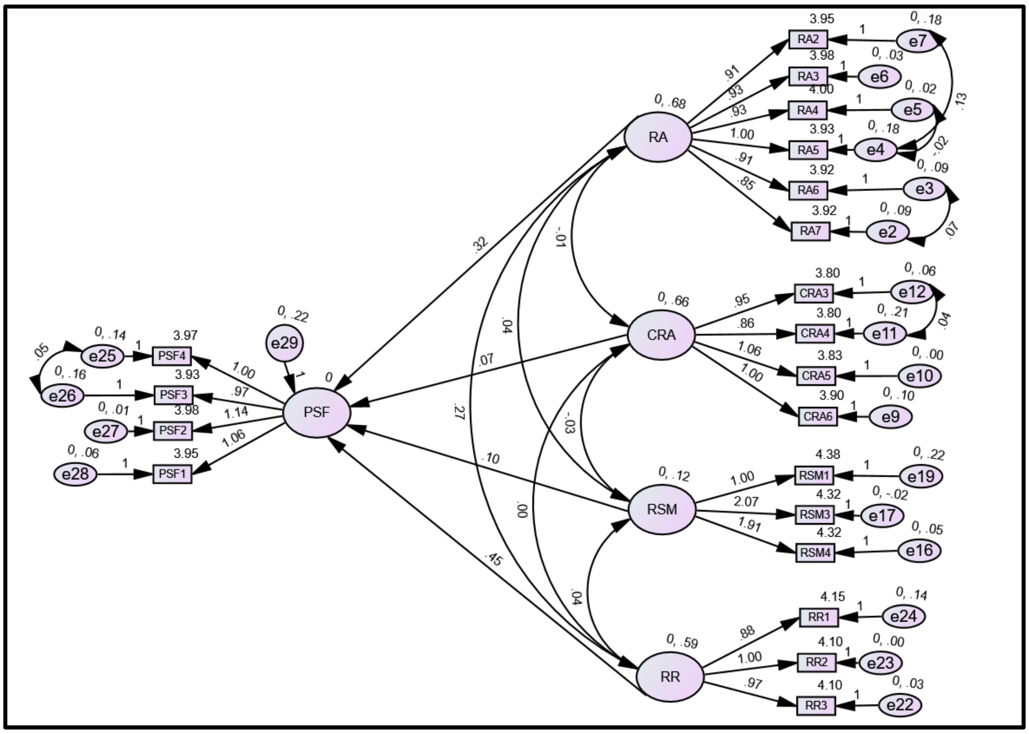
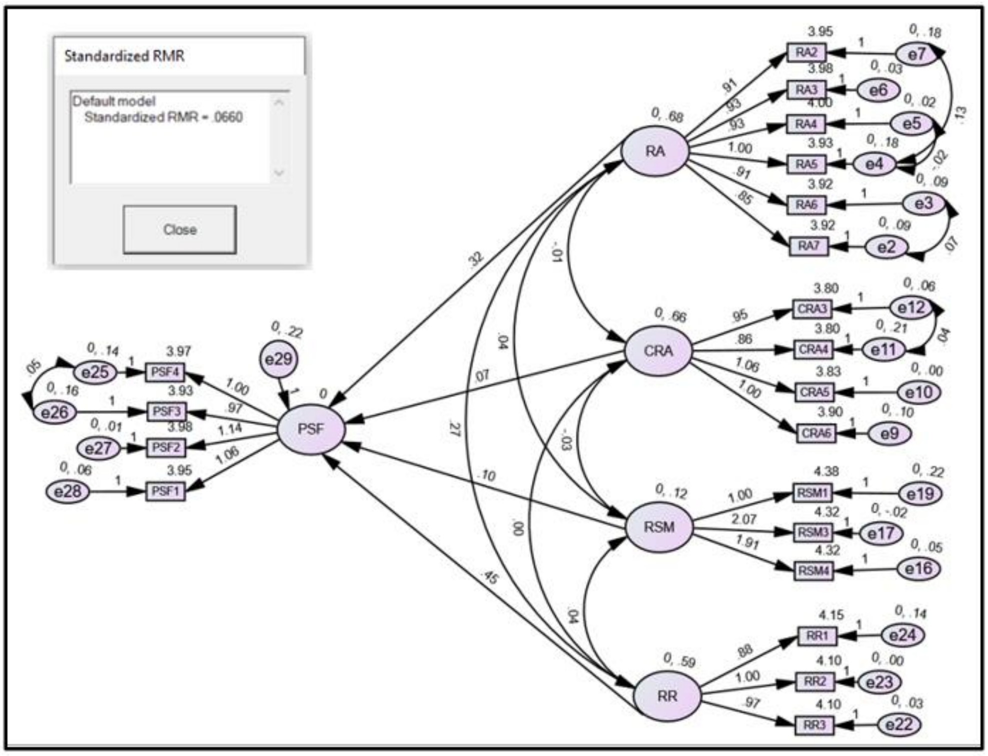


Figure 12: Measurement Model



The initial experiments shows that the model was not fit, and model modification commenced by covaried the high modification indices. Hence, RA1, RA8, CRA1, CRA2, RSM2, RSM5 and RR4 removed to improve the model fit. Modification indices essentially represent chi-square tests for individual equality constraints, indicating that high values suggest the respective parameter constraint is less valid (Arbuckle, 2016).

Figure 13: Confirmatory Factor Analysis Modified Model.



Furthermore, Figure. 13 depicts the modified Model, illustrating the adjustments made to the original model based on the findings of Confirmatory Factor Analysis (CFA). These modifications aim to enhance the fit of the model to the empirical data by addressing discrepancies and refining the measurement model.

For Risk Assessment (RA), the standardized regression weights range from 0.85 (RA7) to 1.00 (RA5), indicating the strength of the relationship between the latent variable and its indicators. In the context of Contingency Reverse Analysis (CRA), the standardized regression weights range from 0.86 (CRA4) to 1.06 (CRA5). For Risk Status Meeting (RSM), the standardized regression weights range from 1.00 (RSM1) to 2.07 (RSM3) and for Risk Reassessment (RR), the standardized regression weights range from 0.88 for RR1 to 1.00 for RR2. For Project Success Factors (PSF), the standardized regression weights range from 0.97 for PSF3 to 1.14 for PSF2.

4.6 Summary of Measurement Model

The process of evaluating model fit (Figure. 14) involves examining how closely the model matches a particular set of observed data points. This analysis aims to gauge the degree of alignment between the model's predictions and the actual observations. Metrics used to assess fit typically encapsulate the extent of the discrepancy between the observed values and those projected by the theoretical model. This comparison helps researchers determine the effectiveness and accuracy of the model in representing the real-world phenomena under consideration.

Figure 14: Model Fit Summary

Model Fit Summary

CMIN

Model	NPAR	CMIN	DF	P	CMIN/DF
Default model	55	285.612	155	.000	1.843
Saturated model	210	.000	0		
Independence model	20	2089.603	190	.000	10.998

RMR, GFI

Model	RMR	GFI	AGFI	PGFI
Default model	.041	.732	.637	.541
Saturated model	.000	1.000		
Independence model	.286	.193	.108	.175

Baseline Comparisons

Model	NFI Delta1	RFI rho1	IFI Delta2	TLI rho2	CFI
Default model	.863	.832	.932	.916	.931
Saturated model	1.000		1.000		1.000
Independence model	.000	.000	.000	.000	.000

Parsimony-Adjusted Measures

Model	PRATIO	PNFI	PCFI
Default model	.816	.704	.760
Saturated model	.000	.000	.000
Independence model	1.000	.000	.000

NCP

Model	NCP	LO 90	HI 90
Default model	130.612	87.023	182.030
Saturated model	.000	.000	.000
Independence model	1899.603	1756.330	2050.270

FMIN

Model	FMIN	F0	LO 90	HI 90
Default model	4.841	2.214	1.475	3.085
Saturated model	.000	.000	.000	.000
Independence model	35.417	32.197	29.768	34.750

RMSEA

Model	RMSEA	LO 90	HI 90	PCLOSE
Default model	.120	.098	.141	.000
Independence model	.412	.396	.428	.000

Figure. 14 indicated the summary of model fit, statistically, the modification indices were given as Chi-square = 285.612, DF = 155, PCMIN/DF = 1.843, P-Value = 0.000, CFI = .931, IFI = .932, TLI = .916, NFI = .863, and RMSEA = .120.

Overall, the model fit analysis indicates a relatively good fit, with the absolute fit RMSEA at 0.120, which exceeds the recommended cut-off of 0.08, highlighting a potential issue with fit quality. This is acknowledged as a limitation attributed to the small sample size, where RMSEA parsimony correction and sample size (N) become relevant factors. As cited by Kenny et al. (2015), for models with limited degrees of freedom (*df*), RMSEA values may often surpass cut-offs even in correctly specified models. The standardized SRMR value at 0.066, achieved as below 0.08. Kline (2005) emphasizes the importance of including specific indices such as the Chi-Square test, RMSEA, CFI, and SRMR in model evaluation. These figures signify that the statistics were deemed adequate and met the minimum criteria for a satisfactory model fit. The analysis results indicated a positive relationship among the constructs.

5.0 Conclusion and Recommendations

5.1 Conclusion

This study aimed to address the issue of construction companies facing significant losses due to insufficient project risk monitoring and control by project managers overseeing R&D construction projects. Its objective was to examine whether implementing project risk monitoring and control practices is associated with project success in such projects. The findings revealed a statistically significant positive correlation between the PMO's prescribed Risk Monitoring and Control Practices, encompassing risk reassessment, audits, contingency reserves analysis, and status meetings and key Project Success Factors adherence to project schedule, effective cost management, fulfillment of facilities requirements, and customer satisfaction in the context of RDD facilities construction. This research offers valuable insights for practitioners seeking to effectively navigate risks within their field. It delves into the intricate connections between project risk monitoring and control practices and project performance, providing project management professionals with a deeper understanding. Organizations can leverage the findings to develop policies and procedures aimed at addressing project risk management challenges, thereby enhancing the likelihood of successful project completion.

The study's results indicated a strong, positive, and significant correlation between project success factors and the implementation of project risk monitoring and control practices. While correlation doesn't imply causation, it suggested that an increase in the utilization of these practices was associated with enhanced project success. Despite participants acknowledging the benefits of these practices, they were not widely adopted, leading to significant financial losses for construction organizations, sometimes amounting to as much as 85% of the total project cost (Senesi et al., 2015). Despite the availability of various project risk monitoring and control practices, many project managers continue to either overlook or hesitate to implement them. This reluctance stems from a lack of awareness regarding the advantages of project risk monitoring and control practices. On the contrary, construction organizations should prioritize the consistent utilization of project risk monitoring and control practices to enhance project success rates. This requires fostering awareness, ensuring ongoing application, and providing adequate training to promote understanding and effectiveness of these practices in R&D construction projects. The study's findings underscored the positive correlation between the use of project risk monitoring and control practice (risk reassessment, audits, contingency reserves analysis, and status meetings) and key Project Success Factors (schedule, cost, facilities requirements, and customer satisfaction). Therefore, by actively and consistently integrating these practices into their daily project activities, R&D and construction professionals can mitigate risks and address challenges prevalent in the R&D facilities construction, contributing to improved project outcomes.

5.2 Recommendation

This study has several strengths that enhance the validity of its findings and underscore the need for further research on this topic in other sectors of the economy. In addition to the R&D facilities construction industry, future research should explore the impact of project risk monitoring and control practices on project performance in various industries such as agriculture, healthcare, and education. Expanding the scope of research to these sectors will improve the generalizability of the current study's findings. According to Podsakoff and Podsakoff (2019), replicating original research with different samples enhances the generalizability of the study results. Understanding how project risk monitoring and control practices influence project performance across diverse industries will help organizations manage, monitor, and control risks more effectively, thereby increasing the likelihood of delivering successful projects. This broader perspective is essential for developing comprehensive risk management strategies that can be applied universally.

The sample size of this study comprised 60 respondents. Due to the relatively small number of participants, it is necessary for future studies to incorporate a significantly larger sample size to obtain more comprehensive information regarding the factors contributing to the issue at hand. A larger sample will help prevent skewed results and better serve the study's objectives. Lin et al. (2013) argued that using large samples enables researchers to detect smaller, subtler, and more complex effects in the study results. However, researchers should exercise caution when using large samples. The sample size should be sufficient to ensure robust and reliable findings but not so large that it alters the significance levels of the study's results. Properly balancing sample size is crucial to maintaining the validity and accuracy of the research outcomes.

Since this was a quantitative study, future research could employ mixed methods to further explore this topic and verify whether the findings remain consistent. Mixed methods research combines both qualitative and quantitative approaches within the same study. Utilizing mixed methods can help researchers avoid biases that are inherent in single-method approaches, allow for the comparison of qualitative and quantitative data, and enhance the accuracy of the study's findings, thereby providing a more comprehensive understanding of the phenomenon under investigation. McKim (2017) argued that studies employing a mixed-methods approach achieve a deeper and broader understanding of the phenomenon compared to studies that rely solely on either a quantitative or qualitative approach. The integration of both methods provides readers with greater confidence in the study's results and the conclusions drawn from them. Although mixed methods could be beneficial for this study, it is important to note that they can be expensive and time-consuming, particularly when collecting qualitative and quantitative data simultaneously. Despite these challenges, the mixed-methods approach offers significant advantages in terms of the depth and reliability of research findings, making it a valuable consideration for future studies on this topic.

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