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# Impact of Project Risk Management on Project Success in Electrical Power Projects

Project Management Engineering

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## ABSTRACT

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The study tries to find out how PRM impacts project results in the electrical power sector and lists the obstacles organisations meet when managing risks.

This research obtained information from power project staff by interviewing 113 individuals using a quantitative approach. A survey approach, where questions were answered on a Likert scale, was followed to obtain insights about the way PRM practises are seen and how they affect cost, time and quality.

It was discovered that practising PRM well is strongly tied to achieving success in the project. Research using statistics discovered that there are strong connexions between the PRM process and the key factors of success: managing expenses well ( $r = 0.695$ ), efficient organisation of workforce ( $r = 0.727$ ) and high quality ( $r = 0.735$ ). Firms that introduced clear PRM processes had higher chances of reaching their objectives in cost, time and quality when there were tech upgrades or changes in regulations.

The framework suggested is aimed at addressing the distinctive requirements and challenges faced in generating electricity. It underlines that a well-established risk culture in the organisation, use of advanced tools and identifying and managing risks are important.

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**Keywords:** Project Risk Management (PRM), Electrical Power Projects, Risk Mitigation, Cost Efficiency, Time Management, Quality Standards, Risk Identification, Risk Assessment.

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## **LIST OF ABBREVIATIONS**

**PRM:** Project Risk Management

**AI:** Artificial Intelligence

**ISPSS:** Statistical Package for the Social Sciences

**RBS:** Risk Breakdown Structure

**RBV:** Resource-Based View

**KPI:** Key Performance Indicator

**GDPR:** General Data Protection Regulation

## **1 INTRODUCTION**

Electric power is an essential component of the different fields of today's society and an important part of economic development processes. Electrical energy generation, transmission, and distribution are the veins of industries, health care, education, and virtually every other sector (Chauhan, 2022). Nevertheless, the nature of the initiatives has become intricate and substantial, thus being relatively risky by their nature. The above discussion shows that electrical power projects are different from other infrastructure projects due to the many factors that can affect them. In such circumstances, PRM is not an optional overhead but a project's vital ingredient if it is to be delivered cost-efficiently, on time, and to the required quality standard (Morrow, 2011).

It was therefore not surprising that the power sector of the economy today has undergone several transformations primarily due to technology advancement, market liberalisation, and the rising awareness of the importance of tapping into renewable energy sources. However, numerous electrical power projects have remained to go through critical phases in angered timelines, for instance, cost overruns, delays, and compromise of quality. These are usually due to various risks happening, which are not well uncovered or well handled. This has been felt to have escalated the need for an elaborate risk management plan that can deal with power project risks and associated issues. The research purpose of this study is to evaluate the effectiveness of PRM practices based on the electrical power projects, using a quantitative that involves the use of the questionnaire (Mesa, 2019).

There are various reasons as to why this research was deemed necessary. Firstly, increasing global energy consumption makes the rationality and effectiveness of power projects to maintain the stability of the economy. This means that failure in project risk management is

likely to accrue many losses not only to the stakeholders of the respective project but also to the community relying on constant electricity supply. Second, the above research explains that competitiveness in the energy sector implies that organizations have to engage in constant improvement of their project management practices. Through managing risks, there are potential benefits that can improve the decision-making of project managers, increase efficiency in the use of resources, increase compliance to timelines, and deliver high-quality work. Thus, this study has the following objectives: The study aims to provide valuable insights that could aid various organisations in the power sector in implementing improved PRM practices (Leung, 2007).

This study goes beyond mere theoretical ones in its importance and implications. As applied, the findings will lend themselves to offering the industry professionals a means of improving the risk management activities. It should be noted that electrical power projects are thought to be of systematic risk that cannot be managed reactively, and thus a proactive approach must therefore always be applied. Possible improvements regarding PRM can result in tremendous values of cost reduction and performance increase, not to mention possible delays minimisation. For the policymakers, the study may help them in identifying the areas of risk management that need to be standardised, which will help in making the environment of the power sector project safer and more efficient(Merrow, 2011).

This study seeks to use the following assumptions at its center: organizations practice risk management, but the adopted strategies incorporate general frameworks that may not suffice when it comes to electrical power projects. Lastly, the ownership of resources as volatile, regulation as stringent, and the constantly changing technology make the risk factor dynamic, which requires a specific approach. This study seeks to make that contribution by applying both research methodologies to explain how PRM affects project success (Lee, 2017).

An important feature of this research is the coincidence of the priority directions of activity—cost, time, and quality sensors—with the management of risks. These factors are also closely linked in electric power projects. For instance, the completion time of the project may be extended, thereby leading to more costs and lower-quality work. Thus, this research aims at explaining the identified interconnections and determining best practices that can eliminate various risks associated with PRM practices regarding these areas (Leung, 2007).

The research is further justified because it fills a significant gap that has not been covered in other academic and practical literature. While there is a wealth of works in the general area of risk management, little has been done on risk management in the electrical power industry (Mesa, 2019).

Altogether, this research fills the rather large research gap pertaining to the necessity of developing an efficient, comprehensive framework for project risk management in the electrical power field. Thus, the marked intention of the research to explore current practices and explore the areas where new concepts of risk management can be introduced is designed to provide the scholarly work and results that can shed more light on the practical applicability of the explained concepts.

### **1.1 Research Gap**

As a result of the review of related literature, a researcher recognises the lack of focused studies with regard to Project Risk Management (PRM) of electrical power projects. The issue of risk management has been widely researched in many fields; however, in the area of power projects, it is a rather weak research domain. Many existing frameworks are developed from a generic standpoint and fail to address issues that may be associated with technology, regulations,

and the environment that is special to the power industry (Chauhan, 2022).

## **1.2 Research Problem**

The research problem of concern is rooted in the chronic challenges experienced in the handling of risks in electrical power projects. Such projects, especially, are characterised by irregular cost overruns, time delays, and compliance with low quality in the final output as a result of negative risks that may arise in the course of projects. It was established that the uncertainty is evident from the variable resource costs that are characteristic of renewable energy production, changes in regulations and legislation, as well as advances in technology, all of which contribute to a dynamic risk profile that cannot be managed through simple strategies. It then leaves project managers and the stakeholders with inadequate elements and understanding to centrally manage risks appropriately, thus leading to unsatisfactory project performances.

## **1.3 Research Objectives**

The research is aimed at analysing how well Project Risk Management (PRM) methods work in electrical power projects. Efforts are put into looking at how PRM shapes key performance factors, for example, cost compliance, time usage and ensuring excellent results.

- To analyse how electrical power projects, practicing the specific PRM practices.
- To monitor existing PRM methodologies alteration in addressing the potential and existing risks in electrical power projects appropriately.

#### 1.4 Research Questions

- **RQ1.** To what extent is currently, in the electrical power projects, practicing the specific PRM practices?
- **RQ2.** What is impact of project risk management on project success in electrical power projects?

In this respect, the study seeks to answer the following questions in order to furnish a workable framework that interprets the results of the empirical tests while, at the same time, exploring the enablers and barriers to effective PRM:

#### 1.5 Limitations

However, it is important to consider some limitations of this study, which is aimed at assessing different aspects of PRM practices in electrical power projects, as follows:

**Limitations of the Research:** This is because the research only focused on electrical power projects, and thus the findings are only relevant to electrical power projects and not any other sector or type of infrastructure projects. To some extent it is deliberately done to provide depth of coverage, but it certainly limits the scope for comprehensiveness.

**Data Availability:** Acquisition of practical project-related data might be difficult because of restrictions to do with sensitivity and ownership. This limitation may lead to the use of secondary research and collecting data based on the impressions of project managers and other team members.

**Interference hindrances:** Despite the highly structural and comprehensive characteristic of the quantitative approach, difficulties arise when making a merger between the quantitative results. It is also important to understand that the aggregation of data and the

manner in which they are collected or analysed vary across studies and could also variably influence the results (Bansal, 2017).

**Bid Team formation Risk:** Electrical power projects take several years, thus making it easy to develop bid teams that are subjected to dynamic risk environments; the findings, therefore, are temporal. Observations may reveal long-term issues, while changes in risk management practices may occur during the study.

## **1.6 Structure of the Study**

The thesis is organized into chapters to ensure a logical and coherent presentation of the research:

**Literature Review:** A literature review of other works on PRM and on electrical power projects is provided in this chapter. In this chapter, the literature review of previous studies is done, and the research gaps and background of the present study are established.

**Research Methodology:** This chapter aims at establishing the work's research study type, the approach taken in the survey method. Information on how the data was collected, instruments used for data analysis, and software employed, such as Statistical Package for the Social Sciences (SPSS) to analyse quantitative data.

**Data Analysis and Finding:** This section is used to present the findings from the two analyses, namely the statistical and the textual. In order to support the understanding of how the topics presented influence the success of a project in terms of cost, time, and quality, the chapter contains graphic illustrations, tables, and discussion topics.

**Discussion and Recommendations:** The findings of the study are discussed here in connection with the research questions and the earlier scholars' arguments. Finally, the research offers advice on how the electrical power sector practitioners, policymakers, and scholars

can improve PRM practices and the implications of the recommendations.

**Conclusion:** The final chapter of the present study is dedicated to the discussion of the findings, the limitations of the research work, and the prospects of the future investigations in the field of project risk management.

## **2 LITERATURE REVIEW**

There is a remarkable degree of practice and research done on the management of risks in electrical power projects, and this is based on a highly diverse approach, which incorporates the fields of project management, electrical engineering, finance, and organisational studies. This section of the literature review presents an overview of the main ideas and wording foundations, or theoretical convictions, that can support the research issue provided in section 3. Also presented is the documentation of the main areas that have been explored in the previous works to show how the various works are related to the main research questions of this study.

### **2.1 Electrical Power Project**

Electrical power projects face unique challenges that set them apart from other types of infrastructure. Generally, these projects stand out due to their high initial investment, extended duration, extensive compliance requirements, and significant technological risks. These factors make it imperative for the power sector to adopt a risk management mechanism that is appropriate for its kind.

There is a wealth of literature on the subject of risk management as it concerns electrical power projects. For example, Bryde (2018) discussed the studies carried out on using risk assessment models in hydroelectric projects and found out the need for taking environmental and technical difficulties into account. In a similar vein, the study by Mesa (2016) was also concerned with thermal power projects but specified regulatory risks and market risks as those that have an impact on the projects. Altogether, these studies specify that risks are diverse in the power sector and require broader risk management plans.

Additionally, researchers have conducted comparative studies to evaluate risk management approaches in electrical power projects. For

example, studies that compare the old waterfall model to the new agile project management paradigms have found that the agile model may be better at handling the risks that come with technology problems and quick changes to the law (Choi et al., 2019). In the presented body of work, the observer gains distinct knowledge of the strengths and weaknesses of different risk management strategies.

## **2.2 Project Risk Management**

PRM is therefore a process that encompasses the identification, evaluation, management, and monitoring of risks that affect a project's goals and objectives (Antillón, 2014). The research studies carried out to address the area of risk management include, but are not limited to, the work of Amorocho (2021), who provide basic information on risk management as a strategic component of large-scale projects. These studies emphasise that PRM should focus on both loss minimisation and risk gain management.

The literature also notes that risk management is not solely quantitative in nature. Probabilistic risk assessment and cost-benefit analysis are two other methods that have been used a lot to find out how risks might affect the performance of a project (Bansal, 2017). This approach is even appropriate for the electrical power project because such projects are always big and have long project cycles.

## **2.3 Project Success**

Project success cost, time, and quality, this research considers factors such as stakeholder satisfaction, project adaptability, and long-term value as measures of project success. Includes many new challenges aside from the usual measures of cost, time and quality. These previous metrics are essential, but new project environments call for using other measures that keep stakeholders happy, support sustainability, prepare for changes and encourage long-term goal

achievement. Jones (2014) said that the best projects are those that cope effectively with new difficulties in large projects, as well as delivering the desired goals. He finds that standard performance indicators do not reflect the evolving hazards and risks affected projects face over their lifespan. Electrical power projects are especially influenced by changing regulations, changing environmental conditions and disruptions in technology (Chauhan, 2022).

According to Dawes (2008), the results of applying project practices such as risk management, are strongly influenced by the situation. His discoveries mean that being successful with projects comes from adapting plans to the conditions at hand, the availability of resources and how the organization operates. The same problems appear in the power industry, where different rules and priorities among communities make it necessary to have custom approaches for rating successes (Cho, 2018). Stakeholder involvement is identified by Cho et al. (2021) as an important factor that makes a project successful. Their studies indicate that teams, authorities and groups in the area working together help handle risks and lower the risk of project failure.

KPI Working Group (2007) also points out that organizational culture greatly affects the results of an organization. Project analysis points out that companies with an adjusted culture toward risks and consistent project goals linked to their values often do better. As a result, this means that companies in electrical power projects need an environment where they share risks, take responsibility and study their past mistakes. For this reason, the literature indicates that success on power sector projects is not uniform, but depends on flexibility, stakeholder agreement and the organization's ability to manage uncertainties.

## 2.4 Research gap

This table depicts fundamental details about some of the conducted research by different authors and how this study can complete the gaps for electrical power project research. The details of various case studies need to be elaborated and more information needs to be included as mentioned (see Table 1).

Table 1 Summary of Literature Review

<b>AUTHOR (YEAR)</b>	<b>RESEARCH DONE</b>	<b>GAP IN THAT RESEARCH</b>	<b>HOW THIS RESEARCH WILL OVERCOME THAT GAP</b>
<b>Aapoja (2014)</b>	Proposed a systematic approach to risk management, emphasising risk identification, mitigation, and monitoring.	Presented a broad, generic framework not tailored to the unique challenges of electrical power projects; limited integration of quantitative insights.	Focuses specifically on electrical power projects and uses a quantitative approach to address sector-specific challenges.
<b>Antillón (2014)</b>	Provided standard guidelines and best practices for project risk management.	Guidelines are generic and do not address the specific risks and complexities found in the power sector.	Adapts PMI's guidelines to the specific context of electrical power projects by considering unique technical, regulatory, and environmental risks.
<b>Amorocho (2021)</b>	Offered comprehensive project management	Lacked a specific focus on the particular risks associated with	Tailors risk management practices to address the distinct technical, regulatory,

	frameworks and practices.	electrical power projects.	and environmental challenges inherent in electrical power projects.
<b>Bansal (2017)</b>	Developed risk assessment models including probabilistic methods (e.g., Monte Carlo simulations) for quantifying project risks.	Limited integration with quantitative insights and not specifically adapted for the power sector's complex risk environment.	Integrates quantitative risk assessment methods to capture contextual nuances specific to electrical power projects.
<b>Attouri (2022)</b>	Explored both quantitative and analytical methods.	Provided comprehensive techniques but without specific application guidelines for electrical power projects.	Applies Attouri's techniques within the context of electrical power projects, addressing sector-specific regulatory and technical risks.
<b>Bryde (2018)</b>	Investigated risk assessment models in hydroelectric and thermal power projects, focusing on environmental and technical risk factors.	Focused on a limited subset of power projects and did not use an integrated quantitative approach.	Expands the scope to various types of electrical power projects and employs surveys for a more holistic understanding of risk management practices.
<b>Boyd (2013)</b>	Introduced the Risk Breakdown Structure (RBS) model to categorize	The model is generic and not specifically adapted to the dynamic risk	Customizes the RBS framework to capture the unique risk categories (regulatory, environmental,

	project risks.	landscape of electrical power projects.	technical) relevant to the power sector.
<b>Dawes (2008)</b>	Introduced contingency theory, arguing that management practices' effectiveness depends on context.	Did not specifically apply the theory to project risk management within the electrical power sector.	Applies contingency theory to analyze how contextual factors in electrical power projects influence the success of risk management practices.
<b>Henneveld (2006)</b>	Explored the relationship between project complexity and risk management strategies.	Lacked a focus on electrical power projects and did not integrate quantitative insights to explain contextual influences.	Specifically investigates the complexity inherent in electrical power projects using quantitative method to capture quantitative dimension.
<b>Iwanski (2013)</b>	Developed the Resource-Based View (RBV), emphasizing how internal organizational capabilities contribute to competitive advantage.	Did not address the application of RBV in the context of risk management for large-scale infrastructure projects such as those in the power sector.	Utilizes RBV to assess how internal capabilities (e.g., technological expertise, risk culture) in electrical power projects enhance effective risk management.
<b>Chauhan (2022)</b>	Examined the link between risk management maturity and	Their research was general, lacking focus on the specific	Concentrates on electrical power projects to evaluate how mature risk

	project performance.	challenges faced by electrical power projects.	management practices impact key success factors (cost, time, quality) within the sector.
<b>Cho (2018)</b>	Highlighted the importance of structured risk management and its positive impact on project performance.	Provided a broad analysis that did not delve into quantitative aspects or address sector-specific challenges in detail.	Enhances previous work by integrating quantitative insights to better capture the unique risk challenges and management practices in electrical power projects.
<b>Cho(2021)</b>	Studied stakeholder engagement and communication within risk management processes.	Focused on stakeholder engagement in general without emphasizing its specific impact on electrical power projects.	Examines stakeholder engagement within the context of electrical power projects, detailing how communication and collaboration affect risk identification and mitigation.
<b>Choi (2019)</b>	Compared traditional and agile methodologies in project management, including aspects of risk management.	Did not specifically address risk management within the electrical power sector.	Adapts agile insights to develop risk management practices tailored to the unique challenges of electrical power projects, emphasizing flexibility and responsiveness.
<b>Elavarasan (2020)</b>	Investigated the relationship between risk management	Did not integrate quantitative insights or account for	Combines quantitative survey data with to provide a richer, context-sensitive

	practices and project performance using quantitative surveys.	context-specific factors pertinent to electrical power projects.	analysis of risk management in electrical power projects.
<b>Jones (2014)</b>	Conducted in-depth case studies on large-scale infrastructure projects to explore the impact of risk management on project outcomes.	Case studies were often limited in scope and did not capture the full diversity of risk factors in electrical power projects.	Expands upon previous case studies by including a broader sample of electrical power projects and employing quantitative research to capture diverse risk management experiences.
<b>KPI Working Group (2007)</b>	Examined the influence of organizational culture on risk management and overall project success.	Studied a variety of projects without a deep dive into the specific challenges and dynamics of electrical power projects.	Focuses specifically on the electrical power sector to analyze how a strong, risk-aware organizational culture impacts project outcomes.
<b>Mesa (2016)</b>	Investigated risk factors and management practices in thermal power projects, emphasizing regulatory and environmental risks.	Focused mainly on thermal power projects, limiting the generalizability to other types of electrical power projects such as hydroelectric or renewable	Broadens the analysis by including various types of electrical power projects and employing a quantitative approach to assess a comprehensive range of risk management practices.

		projects.	
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## 2.5 Project Risk management and project success

Much of the literature related to electrical power highlights the important relationship between success in a project and effective use of Project Risk Management (PRM). According to Elavarasan (2020), strong risk management systems lead to much better results on projects. By using research data, he shows that using structured PRM methods can prevent common delays, overruns in costs and compromises in quality. Still, the author points out that a great deal of the available literature misses important contextual details because it is mostly quantitative. As well as a mathematical likelihood, risk depends on how people see it, the culture of the organization and the rate of change around them in infrastructure areas.

As a result, Iwanski (2013) proposes that using the Resource-Based View (RBV) and focusing on a company's trained staff, technology and solid risk culture supports changing risk management into real project outcome. For electrical power projects, this insight matters because teams must coordinate their skills with expectations from the outside world to do well. Projects are more resistant to disturbances if their risk teams are experienced and they can access helpful forecasting technologies.

Adding to this, the KPI Working Group (2007) makes clear that PRM models depend on the culture within the organization. They found that the better companies are at understanding risks, the quicker they can make decisions, exchange information successfully and correctly spot risks which supports project success. Across years-long and joined projects in electrical power, a culture focused on transparency and early risk management helps prevent failures and leads to success.

Henneveld's (2006) contribution relates project challenges to how easily and effectively PRM strategies can change. Increased complexity in technology, the environment or regulations, he points out, means firms must apply more advanced approaches to managing risk. In the case of electrical power projects, layered interdependencies, involved system setups and unusual external changes are common. According to Henneveld, projects require adaptable risk plans that react promptly, work together with forecasting systems and provide flexibility to managers to support performance.

All of these case studies prove that PRM is part of a wider strategy that directly relates to the success of a project. It is clear from published works that when PRM is matched to the context, reliant on strong abilities within the company and welcomed by a culture focused on risks, projects have a much higher chance of success especially in the demanding field of electrical power infrastructure.

## **2.6 Hypothesis Development**

The literature review showcases the importance of Project Risk Management (PRM) in providing a competitive advantage to a company's project with respect to costs, time, quality and stakeholder value. PRM alleviates risks and uncertainties; more critically, it enhances planning and control, flexibility, as well as resource allocation. It is even more powerful when trust-building communication approaches that reduce interference and foster collaboration are used alongside high-level analytical techniques. In complex and sensitive projects like those pertaining to the electrical power domain, PRM capitalizes on the organizational approaches and pre-defined stakeholder objectives and mobilizes them to actively participate. Taking these perspectives into account, the following hypotheses are constructed (see Figure 1):

Based on the literature review, the following hypothesis is proposed:

H1: Effective Project Risk Management (PRM) improves the performance of electrical power projects in time, cost, quality, and stakeholder satisfaction.

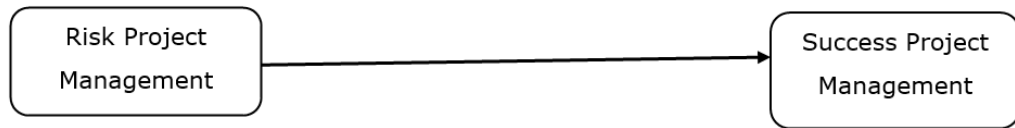


Figure 1 Research Model

## **3 RESEARCH METHODS**

### **3.1 Introduction**

This chapter outlines the research technique used to examine how Project Risk Management (PRM) practices affect the success of projects in the electrical power industry. The research study uses a quantitative approach to gather solid and measurable data from practitioners in the organizing, carrying out and monitoring of power sector projects. Structured questionnaires sent to a selected group are used to discover statistically meaningful relationships between PPM methods and costs, timing and quality in projects.

A quantitative design is often used, so that the results can be very precise, reliable and reproducible. With this system, data is collected and examined in a step-by-step way, allowing proof for or against set hypotheses. This chapter presents the procedures for collecting data, choosing samples, selecting instruments and analyzing the data to produce credible and sturdy results.

### **3.2 Quantitative research.**

Quantitative research systematically retrieves, counts and explores data to check the relationship between different variables using statistics. Scientific sociology assumes that data can be gathered and observed with empirical methods. People use tools such as surveys, questionnaires or tests to obtain numerical data that researcher analyse using statistical software.

For this study, quantitative research was selected to see how different project risk management practices relate to success in electric power projects. Likert-scale questions make it possible to gather responses that can be compared throughout a large population. Afterward,

collected data is checked using statistics, analysis of correlations and evaluation using SPSS software. The findings from quantitative research are general and based on actual observations which means the approach fits well for evaluating risk management results in large infrastructure projects.

### **Justification for the Chosen Design**

The decision to adopt a quantitative strategy was driven by several considerations:

**Complexity of the research topic:** Measurement of risk management activities in electrical power projects can in fact be broken into quantitative or tangible factors, such as completion rates on the project.

**Comparison and complementarity:** Quantitative methods gave coverage of a wide population.

**Higher validity:** Use of multiple pieces of evidence also leads to higher validity of the results and their general disability.

### **3.3 Data collection**

#### **Unit of Analysis**

The population of the study is the working individual who is directly involved in electrical power projects. This comprises the project managers, engineers, planners and risk analysts, depending on the level of participation in the decision-making or implementation within the risk environments of the projects.

GING on a people level allows the research to gather the personal, perceived data, the ways managers approach PRM and the practical issues managers may encounter when using PRM. The study was able

to make the generalisation because data were collected from several individuals and from various types of projects.

### **Research Paradigm**

This research fits with the problem-solving or pragmatic research tradition that does not follow the exact methodologies mentioned before, as it considers different approaches to answer a research question. Hence, pragmatism has the possibility to adopt various approaches, which can include the ideological interpretation with a focus on quantitative research.

This paradigm allows for quantitative research and thus allows the research not only to identify what practices are being employed but also why such practices are used and how they impact the practices being carried out. This is in line with the applied nature of the research, as well as the research objectives to produce knowledge aimed at informing practice and policy in the power sector (Castilla, 2020).

### **Why quantitative research:**

Data in this research was gathered by providing professionals in electrical power projects with surveys. The study relied on Likert-scale questions, so respondents rated their thoughts or experiences from 1 to 5. Due to this structure, information is gathered that can be examined and compared from a large group.

Following data collection from the survey, data analysis was done with SPSS (Statistical Package for the Social Sciences) software. Descriptive analysis, correlation analysis and reliability analysis are all statistically tested in SPSS. Such approaches help discover how PRM activities relate to the results a company hopes to achieve from a project in terms of time, money and quality. Because the results derive from actual data, they can be applied to a greater number of electrical

power projects. With this, we can observe how well PRM helps achieve good project results.

### **How Data Is Analyzed**

The method involves estimating the average (mean) and variation (standard deviation) in how workers see PRM and rate the success of their projects. It helps you see how the data are spread out. It is examined using correlation analysis, particularly Pearson correlation coefficients, to establish the strength and direction of links between PRM practices and how effective a project is in cost management, time management and quality expectations.

### **Survey Design:**

Those surveyed answered Likert-scale questions and multiple-choice questions regarding their opinions about PRM activities, including identifying risks, planning for them and implementing solutions. The questions in the survey questionnaire were adopted from (Anderson, 2022 and Barman, 2015). By using a variety of items for Cost Efficiency, Time Management and Quality Standards, each construct was well evaluated.

### **Sample and Sampling Technique**

113 respondents, who are involved in or working on various electrical power projects, received the questionnaire. The selection of the respondents was based on a purposive sample design to ensure that all of them have some experience in project management and/or risk assessment in the power sector. It was deemed more appropriate than taking a random sample in order to identify people who are knowledgeable regarding the phenomena that were under investigation.

A survey including a questionnaire was sent to 150 people taking part in electrical power projects. Overall, 113 people responded which added up to a response rate of 75.3%. It was seen that the collected data could be analysed well by descriptive analysis, correlation and reliability tests using SPSS (Di Stefano, 2015), Research Process (see Figure 2):



**Figure 2. Research Process Diagram**

### **Quantitative Analysis**

The quantitative data was analysed using a statistical tool known as the Statistical Package for the Social Sciences (SPSS). To quantify the relationships between PRM practices and the project success factors, descriptive statistics, reliability analysis, and the Pearson's correlation coefficients test were used for computing.

### 3.4 Measurement of the variable

The variables of the study was adopted from:

***Project Management Risk:*** The Project Management Risk (PRM) stands on the general risk management frameworks, such as Amorocho& Hartmann (2021), Andersen & Tekula (2022), and Aapaoja&Haapasalo (2014) mostly. These sources provide different procedures and frameworks of risks management in mega projects, and in particular activities risk identification, evaluation, and treatment.

***Project Success:*** Measuring Project Success is broken down into cost effectiveness, schedule adherence and quality to draw on Pinto & Slevin (1988) Cho (2018) and Bansal (2017). The classic metrics defined in these studies are cost, time, quality, and other variables such as stakeholder satisfaction, and long-term value.

## 4 EMPIRICAL FINDINGS AND ANALYSIS

### 4.1 Descriptive Analysis

**Table 2: Descriptive**

	<b>Mean</b>	<b>Std. Deviation</b>
<b>Project Risk Management</b>	17.6142	2.63692
<b>Cost Efficiency</b>	17.4035	2.59105
<b>Time Management</b>	17.3518	2.55396
<b>Quality Standards</b>	17.4779	2.64297

The key variables of Project Risk Management along with Cost Efficiency Time Management and Quality Standards receive statistical analysis through Table 4. Each construct in the table showcases the minimum and maximum scores together with their mean score and standard deviation as a measure of mean-centred score dispersion. The Project Risk Management scores spread from 7.60 to 21.00 points with 17.6142 as the mean score and 2.63692 as the standard deviation. The obtained data demonstrates participants gave an above-average rating towards Project Risk Management assessment while variations existed among their responses. The data points for Cost Efficiency ratings covered a spectrum between 7.60 and 21.(see Table 2)

## 4.2 Reliability

**Table 3:**

		<b>Items</b>	<b>Cronbach Alpha</b>	<b>AVE</b>	<b>Composite Reliability</b>
<b>Project Management</b>	<b>Risk</b>	5	.825	.734	.845
<b>Cost Efficiency</b>		5	.809	.645	.823
<b>Time Management</b>		5	.819	.737	.840
<b>Quality Standards</b>		5	.808	.787	.830

Research reliability data shows that approval comes from Cronbach alpha results for the essential procurement parameters which include Project Risk Management, Cost Efficiency, Time Management, and Quality Standards. The reliability results from all four dimensions follow acceptable standards because their Cronbach alpha scores surpass the minimum threshold of 0.70. The reliability scores for Project Risk Management reach 0.825 along with Cost Efficiency at 0.809 and Time Management at 0.819 and Quality Standards at 0.808. The obtained values demonstrate that the questionnaire items correctly measure the essential constructs for each dimension which supports reliability of these survey variables. (See Table.3)

### 4.3 Correlation

**Table 4:**

	<b>Project Risk Management</b>	<b>Cost Efficiency</b>	<b>Time Management</b>	<b>Quality Standards</b>
<b>Project Risk Management</b>	1	.695**	.727**	.735**
<b>Cost Efficiency</b>		1	.826**	.797**
<b>Time Management</b>			1	.766**
<b>Quality Standards</b>				1

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

**Table 4: Correlation**

Pearson correlation coefficients within the correlation table demonstrate how each procurement dimension relates to the rest. The data demonstrates Project Risk Management presents robust positive relationships across every other variable including Cost Efficiency (0.695), Time Management (0.727) and Quality Standards (0.735). All these correlations maintain statistical significance at  $p < 0.001$ . Cost Efficiency shows significant positive statistical relationships between Time Management (0.826) and Quality Standards (0.797) and these performance factors display their own positive association (0.766). The collected data proves that advancing within one parameter creates corresponding enhancements across all other parameters as the different parameters collectively support procurement success. All correlations demonstrated strong significance which verifies the solid connection between project risk management and time management and quality standards and cost efficiency in procurement processes. (See Table.4)

## **5 DISCUSSION**

### **5.1 Introduction**

In this chapter, the researcher provides a summary of the entire study, together with the responses to the study questions and propositions in the theoretical framework and literature. It starts with the restating of the research problem, questions on the study, and hypotheses. It then delves into discussing and explaining the implications of the results, outlining the scholarly impact and the contribution of best practices to risk management in electrical power projects. The final section delves into the study's contributions, limitations, managerial implications, and recommendations for future research.

### **5.2 Restating the Research Context**

As electrical power projects become more complicated and regulated, as well as due to the growth and development of technology, there is a great need to adopt best practices in PRM. Time, schedule, and cost control issues are recurring, which stem from uncontrolled or unpredictable risks. Generally, these PRM frameworks are in place, but their implementation in power projects is not widespread or contextually relative and has limited literature documenting it specifically in the quantitative approach (Anderson, 2022).

### **5.3 Summary of Key Findings and Interpretation**

#### **Extent of PRM Implementation**

Indeed, the results of a survey indicated moderate to high levels of PRM implementation in power projects with multiple uses of tools such as risk registers, contingency plans, and risk mitigation strategies. Though, emerging from the descriptive analysis of log data is variability depending on the type of projects, which are renewable or traditional, location and the maturity of the organizations. Renewable projects have much more susceptible and dynamic forms of the risk

management system, as they are sensitive to changes in environmental conditions and policies while utilising modern technologies; on the other side, traditional thermal and nuclear projects rely on efficient but rigid forms of the system.

This indicates that PRM implementation depends on the contextual factors in coordination with the contingency theory. Therefore, there is evidence for Hypothesis 1 (H1), which states that PRM practices are used to a certain degree based on project characteristics (Barman, 2015).

### **Impact on Project Outcomes**

Thus, correlation analysis proved statistically significant correlation of PRM implementation with all three criteria of success.

This was in agreement with the study findings, where managers attributed the benefits of structured PRM to being able to predict customer demands and manage resources efficiently. The research showed that projects which had RTMs were more likely to remain on cost and time estimates, especially when the project entailed the application of technology or was executed in an environment that had sensitive conditions.

These results support the second hypothesis, which is that the symptom for the completion of this study is the finding that PRM has significant influence in determining project performance, hence supporting Hypothesis 1 (H1). They also underpin the literature which links good PRM with uncertainty reduction and favourable performance among the stakeholders (Cho, 2018).

## 5.4 Theoretical Contributions

This research has developed the following theories:

**The contingency theory** easier supports the notion that the success of PRM varies from one project to another because of certain factors, like type, size, and location. The study contributes to the theory by making an attempt to apply it to actual risk practices in the electrical power sector that has not been investigated as intensively as other industries (Bugg-Levine, 2011).

**Risk Breakdown Structure (RBS):** The subdivision of the risk into technical, environmental, regulatory and operational was convenient. The next part of the analysis compares the identified categories based on their degree of application across various project types.

**Resource-based view (RBV):** This research supports and confirms the notion that firm-specific resources (people, technology and culture with regards to PRM) play a very strategic role in the effectiveness of PRM. About high-risk maturity and tech-savviness – The findings offered by the study show that organizations that have high-risk maturity and high tech-savviness are better placed to perform in volatile environments.

**Combined Approach in PRM:** This work is unique because quantitative approach is used to investigate PRM in power projects. Organisational members also explained how integrated designs provide more useful information in the research process.

## 5.5 Managerial Implications

For the industry professional and the project manager in particular, the study has the following practical implications:

**Specified issues of PRM frameworks:** In any given project, the PRM frameworks have to be adapted to the complexity of the project,

the geographical location and the regulatory requirements (Bugg-Levine, 2009).

**Advanced technology usage:** Businesses should enhance usage of technological features such as predictive analytics, AI and real-time dashboards to ensure quicker response and effective planning of the risks.

**Promote an organisational culture of risk management:** This means that when everyone in an organisation becomes aware, for example, of changes, ownership, and early indicators, this will greatly assist in proactively managing risks.

**Eliminate voids:** Involve those affected by the risks to eliminate voids, avoid misinterpretation of the risks, and enhance their management.

**Ensuring enough staff:** Staff ought to be trained and upskilled to be on par with the emerging risks, especially in technological projects (Busch, 2021).

## **5.6 Strengths and Limitations of the Study**

**Strengths:** Primary advantages include providing a combination of both a wide scope and in-depth focus, which facilitates the procedure of cross-verification and thus enhances validity.

**Sector-specific concern:** No research exists concerning electrical power PRM with both an analysis of quantitative data, therefore making this research unique.

**Substantial theoretical framework:** It was beneficial to use three kinds of theories (RBS, contingency, RBV) in order to have a broad and detailed analysis.

There is a variety of methods for selecting participants, but each of them presents certain flaws: for instance, purposive sampling is efficient though not highly generalisable (Business Roundtable, 2019).

**Cross-sectional design:** Captured a snapshot rather than longitudinal risk management evolution.

Self-reported data might be inaccurate due to recall bias; however, the studies in the respective articles validated their findings by using other methods.

## **6 CONCLUSION**

### **6.1 Suggestions for Further Research**

These are expansion areas for future research as follows:

- Longitudinal research in order to study changes of PRM in the course of the project's life cycle.
- Focusing on particular types of projects to gain insights into the specific nature of risk management in certain sub-sectors (for instance, offshore wind in contrast to nuclear).
- Propose PRM maturity models taking into account both technical and change management aspects of risk.
- The study aims to identify the differences in PRM practices between countries, particularly between emerging and developed countries (Busch, 2021).

Electrical power projects as well as creates a platform for future research of the increased role of various types of risks, technologies, and performances in high-risk projects.

### **6.2 Methodological Limitation**

The following limitations must be noted despite the fact that this study involved the use of stringent quantitative procedure:

#### **Limitations of Quantitative Analysis**

However, correlation analysis, as shall be shown, presents an excellent picture of association without implying causation. However, based on the purposive sampling method used in the study, it is difficult to generalise the findings to the whole industry.

### **Convergence of Results**

As would be expected, there was a close similarity between the two data sets. Adoptions of the Practice Relation Model were significantly linked to the measure of key project performance (cost, time and quality). This is in line with the statistical relationship based on the self-assessment of cost efficiency identified in the survey.

### **Complementarity of Data**

The above methods were also transcendental to each other in the following ways/means. Broad conclusions using the data collected from over 100 participants were possible thanks to the given survey (Castilla, 2020).

### **Sampling Limitations**

Other methods like purposive and snowball sampling were helpful to target informed participants, but they (inevitably) cause selection bias (Casanovas, 2022).

### **Self-Reported Data**

The survey collected information on people as they reported on their own experiences; thus, they were subjected to a social desirability bias and recall bias. Even though anonymity is guaranteed and the data cross-checked, it is possible to experience certain disadvantages of using self-completed questionnaires.

### **Integration Challenges**

One of the difficulties of the present research was in integrating data collected from different methods, which enabled the integration issue, such as the disparities in themes and their analysis between the two datasets, to arise. In more general data gathering and analysis, it was ensured that the coding mechanism and style adherence to a broad

framework for incorporation and analysis of data did mean that a certain level of interpretation complexity may have been lost during coding and synthesis of data.

### **Contextual and Temporal Limitations**

The findings are derived from electrical power projects only and thus can only be exported to other electrical power projects and may not hold for other forms of infrastructure or IT projects. The cross-sectional design provides a single time point, and cross-sectional findings would be useful in the detection of changes in PRM practices over time (Carton, 2018).

### **6.3 Final Conclusion**

The present research aims to examine the effects of PRM on determining success in projects within the electrical power industry using both quantitative research methodology. It agreed with the author's statements about PRM being widely used and linked to good performance (cost, time, quality) but also more fixed at context, culture, and capability factors (Cardador, 2017). The use of surveys makes this research a valuable addition to the theoretical body of knowledge, as well as furthers practical implications. It provides an appropriate answer to a lack of literature since it presents a sectorial, methodological, and theory-based approach to risk management in a critical area of world infrastructure. It also broadens our knowledge of how to deal with risk issues in a more efficient way while implementing

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## APPENDICES

### Appendix 1: List of Definitions

For clarity and to ensure a common understanding throughout the thesis, several key concepts are defined as follows:

**Project Risk Management (PRM):** A method through which risks that can have a negative effect on the achievement of project goals are evaluated, controlled, and constantly managed. In the context of electrical power projects, PRM are contingency measures that address technical, financial, regulatory, and environmental risks (Cho, 2018).

**Electrical power projects:** These are the massive projects in the provision of electricity, for instance, generation, transformation, and distribution. These reforms can refer to, for instance, hydropower, thermal power, renewable energy including wind and solar power, and nuclear power plant projects, each of which may present ranges of difficulties and various kinds of risks (Cho, 2021).

**Project success:** The attainment of specific project goals with reference to the control of costs, time, and quality. Success in this case is considered in relation to the extent to which PRM practices reduce the risks that, if not managed, would cause variances in these areas (Nassar, 2014).

**Risk Estimation:** The identification of dangers that may have an impact on the achievement of the project in a negative manner (Pinto, 1988).

**Risk Evaluation:** Establishing the probability and magnitude of the risks that have been noted.

**Risk Management:** They are still as follows: Risk Mitigation: Working on such plans that can help in preventing the future occurrence of such risks or their undesirable consequences (Aapoja, 2014).

**Risk Review:** The continuous process of identifying various risk influences and the efficiency of the control and management processes during the project's flow.

## Appendix 2: RESEARCH SURVEY QUESTIONNAIRE

The Questionnaire of the Survey was adopted from (Sameh Monir El-Sayegh, 2014).

1	2	3	4	5
Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree

<b>Project Risk Management</b>						
<b>PRM1</b>	Our team holds dedicated planning meetings to develop the risk management plan.	1	2	3	4	5
<b>PRM2</b>	We develop a Risk Breakdown Structure (RBS) to define risk categories.	1	2	3	4	5
<b>PRM3</b>	We estimate resources/costs for risk management activities and include them in the project budget.	1	2	3	4	5
<b>PRM4</b>	Risk management activities are clearly defined and included in the project schedule.	1	2	3	4	5
<b>PRM5</b>	We develop probability and impact scales specific to each project objective.	1	2	3	4	5
<b>Cost Efficiency</b>						
<b>CE1</b>	Our team consistently identifies and implements cost-saving opportunities	1	2	3	4	5
<b>CE2</b>	Budget allocations align precisely with actual project requirements	1	2	3	4	5
<b>CE3</b>	We maintain effective controls against resource waste	1	2	3	4	5
<b>CE4</b>	Financial risks are proactively mitigated through early interventions	1	2	3	4	5
<b>CE5</b>	Cost-benefit analyses drive our decision-making processes	1	2	3	4	5

Time Management						
<b>TM1</b>	Project milestones are consistently achieved ahead of schedule	1	2	3	4	5
<b>TM2</b>	Buffer times are strategically allocated for high-risk tasks	1	2	3	4	5
<b>TM3</b>	Resource leveling effectively prevents schedule bottlenecks	1	2	3	4	5
<b>TM4</b>	Critical path activities receive prioritized resource allocation	1	2	3	4	5
<b>TM5</b>	Schedule variance is systematically tracked and corrected	1	2	3	4	5
Quality Standards						
<b>QS1</b>	Deliverables consistently exceed client quality expectations	1	2	3	4	5
<b>QS2</b>	Our QA processes detect defects before client handoff	1	2	3	4	5
<b>QS3</b>	Continuous improvement is embedded in our workflows	1	2	3	4	5
<b>QS4</b>	Quality metrics are quantitatively measured and analysed	1	2	3	4	5
<b>QS5</b>	Client feedback directly informs quality enhancement initiatives	1	2	3	4	5