The Efficacy of Innovative Project Management Tools in Mitigating Risks and Uncertainty in the Project Delivery Process

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Abstract

The project delivery process is vulnerable to the contractual relations, roles and responsibilities of clients, contractors and consultants. Scholars view that construction projects are vulnerable to risks and uncertainty when project management fails to integrate stakeholders' interests and resolve the tension between the stakeholders' power expectations. This study examines the nature of project risks and uncertainty and the effectiveness of an innovative project management tool (the SAP_PPM system) in mitigating risks and uncertainty in the project delivery process. This study adopts a qualitative research approach that interviews project managers in South Africa to obtain the data to address the study problem. The study found that the failure of projects occurred when project risk and uncertainty resulted in litigation, stakeholders dissatisfaction and project delay. An emergent theory was identified, substantively explaining that using the SAP-PPM system in the project delivery process mitigates project risk and uncertainty because of its usefulness for resource allocation, priority setting, and timely project performance monitoring. Therefore, the study recommends using SAP-PPM to enhance the opportunities and strengths of the project delivery process.

Keywords: Project Performance, Risks, Risk Management, SAP-PPM System, Uncertainty and Vulnerability

Introduction

The project delivery process is a comprehensive course of action, which comprises project scope and definition, the organisation of designers, contractors and various consultants, the sequencing of design and construction operations, the execution of design and construction, and a beginning and an end [1]. The project delivery process outlines the organisation's design, the financing of the design and construction, and operational and maintenance activities that facilitate the delivery of the project goal and objectives. The complexity of the project delivery process is evident in the complex decisions such as the contractual relations, roles and responsibilities of owners, contractors, and consultants that must be made to ensure the project's success (ibid). According to Kallow et al. [2], the uncertainties associated with the fundamental management process in the project life cycle require a more detailed description of the project life cycle stages.

These complex decisions are subject to human-centric decision-making and pose certain levels of risk and uncertainty concerning the project expectations and outcome [3]. Apart

from the complexity of decision-making, project risk and uncertainty may result from a lack of clarity, incomplete and inaccurate information, a lack of data, a lack of a resolute platform, inappropriate assumptions, bias, and ignorance about the project context [2]. These sources of project risk and uncertainty are inherent in any project [3].

The mitigation of risk and uncertainty is essential for successful project delivery. According to Benta et al. [4], project risk mitigation as an integral part of project delivery increases the probability and impact of positive events. It decreases the likelihood and impact of adverse events in the project. Spedding and Rose [5] noted that project risk mitigation focuses on not eliminating risks but managing them actively and turning uncertainties into economic opportunities through detailed planning, controlling response action, and implementation. Project risk mitigation requires accountability and conscious effort to reduce risk and uncertainty [4]. This emphasises the necessity of a suitable project management tool that will effectively identify project risk and uncertainty, prioritise risks for action-oriented information, and manage project risks [2, 6, 7].

Sarbazhosseini et al. [8] described the tools for ensuring effective and efficient risk mitigation in project delivery as project portfolio management tools. Nylen [9] reported that SAP project portfolio management (SAP-PPM) is a tool that allows project managers to mitigate project risks and uncertainties by planning for time, cost, budget, material, project resources, and collaboration. According to Nylen [9], SAP-PPM is capable of aggregating, integrating, and analysing project data, enabling the simulation, prioritisation, and management of decision-making in the project delivery process. This means that project portfolio management tools must have a broad set of functionalities that will enable risk mitigation and optimisation of resources for successful project delivery.

In the past decades, many theoretical methods have been proposed to assist project managers in evaluating and selecting a project delivery system logically and systematically [10, 11]. For example, authors [12, 13] proposed the use of case-based reasoning (CBR) in project delivery. Ng et al. [14] applied the fuzzy set theory to select a project delivery method. Tran and Molenaar [3] presented a risk-based modelling methodology for choosing the best project delivery method. A web-based selection tool for selecting a project delivery system was developed by authors [15].

Evidence abounds on the SAP project portfolio management (SAP-PPM) efficiency as the best software for mitigating risk and uncertainty in the project delivery process. Hanseth and Braa [16] reported using the SAP-PPM system to deliver the Hydro Agri Europe (HAE) project. The report accounts for the usefulness of the SAP-PPM system in providing a transaction process (although the service was outsourced due to limited computer availability at that time), sending information about tasks through emails, and integrating organisational units for shared activity among people from different parts of the division.

Nylen [9] concluded that there is a need to introduce software technologies such as the SAP-PPM in the project delivery process because project risk management is complex. This results from the different types of risks typically encountered in the project delivery process, such as market risk, political risk, technical, financing, environmental, cost estimate, schedule, operating, organisational, integration and force majeure risks. SAP is a leading supplier of

project portfolio management software solutions and consulting services to offer a complete business environment for e-business throughout the project lifecycle [17].

Project delivery processes are characterised by a lack of strategic alignment, underestimation of cost and capacity, an incomplete statement of requirements, an incomplete overview of all planned and proposed projects, insufficient project registration, and insufficient monitoring of all key performance indicators of project portfolios. The suitability and efficiency of SAP-PPM for mitigating risks and uncertainties have been reported in the literature, and it is widely used by project managers.

Different project departments are implementing the SAP-PPM system in the City of Cape Town, South Africa. The reason and purpose for this adoption of the SAP-PPM system are poorly understood if not unknown. Therefore, it becomes imperative to investigate what needs inform the adoption of the SAP-PPM system in the City of Cape Town. Also, it is important to examine whether SAP-PPM adoption focuses merely on auditing the different aspects of budgeting and spending of project finances rather than ensuring that the project delivery process is rid of risks and uncertainties. Hence, this research examines the effectiveness of SAP-PPM in the City of Cape Town and its impact on project risks and uncertainties. The study posits that SAP-PPM is a highly effective tool in reducing and mitigating the risk and uncertainty generated by the project delivery process. Following this introduction is the review of relevant literature after which the research methodology is presented. The data presentation and analysis come after this before the discussion of the findings. The last section is the conclusions and recommendations section.

Literature Review

Project Risks and Uncertainties in the Project Delivery Process

Project risk is defined by PMI (Project Management Institute) [18] as an uncertain event or condition that, if it occurs, has a positive or a negative effect on at least one project objective, such as time, cost, scope, or quality. Events are certain if the probability of their occurrence is 100% or uncertain if the likelihood of occurrence is 0% [19]. In between these extremes, the uncertainty varies quite widely.

Overview of Tools used in the Mitigation of Project Risk and Uncertainty

Several studies on risk mitigation in project management have provided risk mitigation tools and frameworks for project managers to work with while handling a project. These include the risk mitigation tools as identified and proposed in Table 1.

Table 1 Risk Mitigation Tools

Risk mitigation tools	**References**
Cause and effect analysis	[20, 21,22, 23, 24, 25, 26, 27]

Risk mitigation tools	References
Influence diagrams	[28, 29]
Fault and event tree	[29, 30]
Failure mode and effect analysis	[29]
Probability and impact grid	[29]
Sensitivity analysis and simulation	[31, 32]
Portfolio management	21- 27, 33]

Authors [26] investigated the basic risk management tools and their key features, such as explicit quantitative analysis capabilities. The study analysed sixteen software tools and ranked them in terms of the available features and functionalities. The study demonstrated that using appropriate software tools may enhance project-related operations and reduce costs, especially when the user is a Small, Medium Enterprise. With regard to a more advanced intelligent tool, Dhlamini et al. [34] found that there was a need for an intelligent risk assessment and management tool for both agile and traditional methods in software development projects. The findings in the study led to the proposition of a model whose development is the subject of further research, which can be investigated for use in developing intelligent risk management tools. Linares [35] proposed Multiple Criteria Decision Making and risk analysis as a risk management tool for power systems planning. The study explained that risk analysis, consistent with the multiple criteria model used before and which applies classical decision rules for selecting the best planning strategy under uncertainty, would produce a much more flexible and efficient risk management strategy. The study further claimed that this system would significantly reduce environmental risk with only a small cost increment.

Research Methodology

The study adopted a qualitative research approach which was informed by the need to uncover the complexity and reality that surrounds the use of SAP-PPM for project delivery and also by the need to find rich information and explanation about its usefulness as a risk-mitigation tool from the daily life and project experiences of the project manager in the City of Cape Town. The study applied grounded theory (using concepts, theoretically relevant constructs, or categories, and used theoretical sensitivity to explain the problem. It was important to uncover theories to explain the usefulness of SAP-PPM as a risk mitigation tool and the nature of project risks and uncertainties in the project delivery process.

The population for this study consists of project managers working for the City of Cape Town, South Africa. The project managers were considered the study's target population because they managed the project delivery process and used SAP-PPM for project execution and delivery. Purposive or convenience sampling was used to select participants [36, 37]. A total of ten project managers were selected, and they were interviewed for the study. The number of project managers considered for this study followed the recommendations of authors [38, 39] for grounded theory research.

The sample size of ten project managers was considered appropriate and adequate when theoretical saturation was reached - new categories or explanations stopped emerging from the data. The data was collected via written interviews because of the safety protocols required to minimise the possible risk of COVID-19 infection. The questions in the interview were structured, unbiased, non-directed, and open-ended. Hence, there were no direct encounters between the participants and the researcher.

Grounded theory has been described as a strategy for generating theory [40]. As done in this study, the constructivist grounded theory analysis procedures follow the four-stage process of coding, concept-building, categorising, and theory-building. The coding process deals with the abstraction of the responses to form concepts and the numbering of the concepts. Codes (a summary of the content of the interview text in a few words) were used to denote data segments with a short name that simultaneously accounts for and summarises the data. This process serves as the pivotal link between data collection and theory building.

Data collection was carried out concurrently with data analysis. This was done to ensure that data analysis guided data collection by using insights from initial data collection and analysis for subsequent data collection and analysis. Initially, data were collected from seven participants, and the grounded theory analysis yielded theories that applied to the research question and objectives. However, to achieve theoretical saturation and validate the reliability of the data, three more participants were contacted to collect new data for the study. The relevance of the new data to the developed theories confirmed the reliability and validity of the data and confirmed the theoretical saturation of the grounded theory analysis.

General research ethics and COVID-19 impact protocol that were considered include: Informed consent obtained from the participants before the interview; Participants were given the opportunity and possibility to opt out of the research; The voluntary consent of the participants was secured before the interview; Participants were informed about their right to withdraw at any time during the interview; Participants' identity is not revealed, to ensure anonymity; and Data was gathered solely for the study.

Data Presentation and Analysis

This section presents the grounded theory analysis of the data collected about the efficacy of the SAP Project Portfolio Management (SAP-PPM) System in mitigating risk and uncertainty in the project delivery process of the City of Cape Town. The data analysis reflects the participants' account of their understanding of the project risks and uncertainties in project delivery, features, and functionalities of SAP-PPM, the impacts of project risks and uncertainties on the success of the project delivery process, and impact of SAP-PPM in mitigating project risks and uncertainties. The grounded theory analysis was shaped through open coding, conceptualisation, categorisation, and theory building.

Background details of the respondents

The background details of the participants are provided in Table 2.

Table 2. Background details of the respondents

Name	Designation	Number of years using SAP-PPM	Education	Work experience and duties
Participant 1	Professional officer	8	Property studies	Oversee refurbishments of city-owned properties in waste management
Participant 2	Special project manager	5	Project management	Building refurbishments and construction assessments, spatial planning, SAP-PPM implementation, and feasibility studies
Participant 3	Project senior professional officer	10	Construction management	Activating and controlling all aspects of procurement, budgets, stakeholders, risk factors, and lifecycle
Participant 4	Project manager, urban development implementation	4	Civil engineering	Spatial planning and environment, retaining wall construction, concrete batching plant management, project design and supervision, implementation agent for transport and community services
Participant 5	Principal professional officer	12	Property studies	Facilities management
Participant 6	Project manager	5	Project management	The client project manager, project and contract reporting, project implementation
Participant 7	Project manager	3	Project management	Project implementation
Participant 8	Special project manager	15	Property studies	Facilities management, refurbishment of buildings, and general property administration
Participant 9	Project Administrator	3	Project management	Project support and monitoring, project review
Participant 10	Senior professional officer	4	Property studies	Property management, project administration, technical inspections, project tracking, and reporting

Table 2 shows that the participants were project management professionals, according to their designations and job titles. The designations include professional project management officers (participants 1, 3, 4, 6, 7, and 9), special and senior project manager (participants 2, 8, and 10), and principal project managers (participants 5). This means the participants had the required professional standing and would give legitimate information. To further confirm the legitimacy of the information elicited from the participants, they were requested to indicate the number of years that they had been using SAP-PPM. As shown in Table 2, all the participants used SAP-PPM for at least three years (participants 7 and 9) and a maximum of 15 years (participant 8). This indicated that the participants would give accurate, authentic, first-hand information on using SAP-PPM.

All the participants were educated with degrees in relevant fields such as property studies (participants 1, 5, 8, and 10), project and construction management (participants 2, 3, 5, 6, 7, and 9), and civil engineering (participant 4). This suggests that the participants had the knowledge and skills they needed to understand the interview questions. The work

experience of the participants covered property refurbishment (participants 1, 2, and 8), SAP-PPM implementation (participants 2 and 4), project design and supervision (participants 4 and 9), project implementation (participants 2, 4, 5, and 7), facilities and property management (participant 5, 8, and 10), and project tracking and reporting (participants 10 and 6). This indicated that the participants were connected to the area of this study and would give practical information that would aid the answering of the research question.

Project risks and uncertainties in the project delivery process

The participants were asked to describe the project risks and uncertainties in the project delivery process in the city of Cape Town. It emerged that all the ten participants agreed that risks and uncertainties would occur in the project delivery process if the appropriate expertise were not utilised for the project, the scale of investment was unknown, the time and volume of work were unknown, there were numerous assumptions made, and data was insufficient. The participants emphasised the significant project risk of not matching the expertise and experience of project managers and project participants with the project needs. This is demonstrated in the following excerpts:

"The project delivery process will experience risks and uncertainties if the seniors with more experience are not assigned to the more complex projects; if the number of funds to be spent and its anticipated return is unknown; if the number of efforts to be placed into the project is unknown; if various project managers are assuming various positions and opinions that are not within their capabilities; if corrupt and unsuitable data are used, and if there is a change in management and political landscape." Participant 1

"Complex projects must be allocated to employees with the necessary skills and expertise. The number of funds injected into a project and the amount of effort must match the expected benefits. If these are not done, the project is exposed to risks and uncertainties. Inaccurate and insufficient data also constitute project risk." - Participant 3

There was also consensus among the participants that political meddling, vested interests, unrest, and intimidation were considerable risks to the project in the project delivery process. This is demonstrated in the following excerpts:

"I think the biggest risk is political interference and natural disasters – e.g., currently the unexpected Corona pandemic, results in unplanned expenditure which could lead to change in budgets/priorities." - Participant 3

"Priorities change and funds are redirected elsewhere leaving the planned projects to be either cancelled or to be put on hold." - Participant 10

Importance of SAP-PPM as a mitigation tool for project risk and uncertainty

The participants were asked to explain how important SAP-PM was to mitigating project risk and uncertainty. All participants were able to identify that the importance of SAP-PPM as a mitigation tool for project risk and uncertainty included its usefulness for portfolio inventory, scenario modelling, portfolio monitoring and review, time and cost planning, budget and

material planning, project scoping, demand definition. As agreed to by all the participants, the other importance of SAP-PPM was its usefulness for project staffing, capacity management, time management, project collaboration, project accounting, and project procurement. A comment by Participant 4 clarified these concepts:

In terms of project procurement, aligning demand plans to projects and cash flow has improved (not all agree) better management of the Supply Chain and related resourcing, removing the peaks in tender administration and thereby better balancing service providers' demand. Bottlenecks in the process can now be evidentially purported and mitigation plans considered for improvement." – Participant 4

The participants also noted that SAP-PPM gives a systematic approach to lessening risks and uncertainties in the project delivery process. The following excerpts explore this argument:

"I have been using SAP-PPM for the past eight years to have a systematic approach to all projects. The software allows a systematic approach to lessening risks and uncertainties." – Participant 1

In addition, some participants perceived that SAP-PPM enables the development of risk mitigation plans. This is demonstrated in the following excerpt:

"An IT system cannot mitigate risk; people do. The system, however, allows the institution to create a governance structure that compels the user to provide evidence of having considered pertinent steps in the process, for example, 'does the land you're proposing to invest in belong to the city?' The system then can house real data for analysis, which has been revealing interesting learning for the organisation to build on and mature.' – Participant 4

Enablement of an appropriate governance structure, creation of stability in project organisation and resource use, empowerment of project organisations for collaboration, and enablement of the better scoping of the specification is the importance of SAP-PPM as identified by individual participants.

Discussion of Findings

Causes of Project Risks and Uncertainties in the Project Delivery Process

The grounded theory analysis offers a theoretical framework that explains the project risks and uncertainties in the project delivery process (see Figure 1). The framework presents the insight that suggests that project risk and uncertainty are mainly caused by any of the following: a natural disaster, conflicting stakeholders' interests, politics, inefficiency, corruption, and improper planning. This indicates that project stakeholders and natural disasters are mainly responsible for project risk and uncertainty in the project delivery process. Project stakeholders have different interests that must be integrated to establish the project feasibility and performance measures. Failure to do this creates a conflict in the project expectations and will constitute project risk. The interplay between the stakeholders' expectations may create political tensions about the allocation of funds, project execution

and planning, selection of the project team, and project priorities. This generates risk and uncertainty in project delivery.

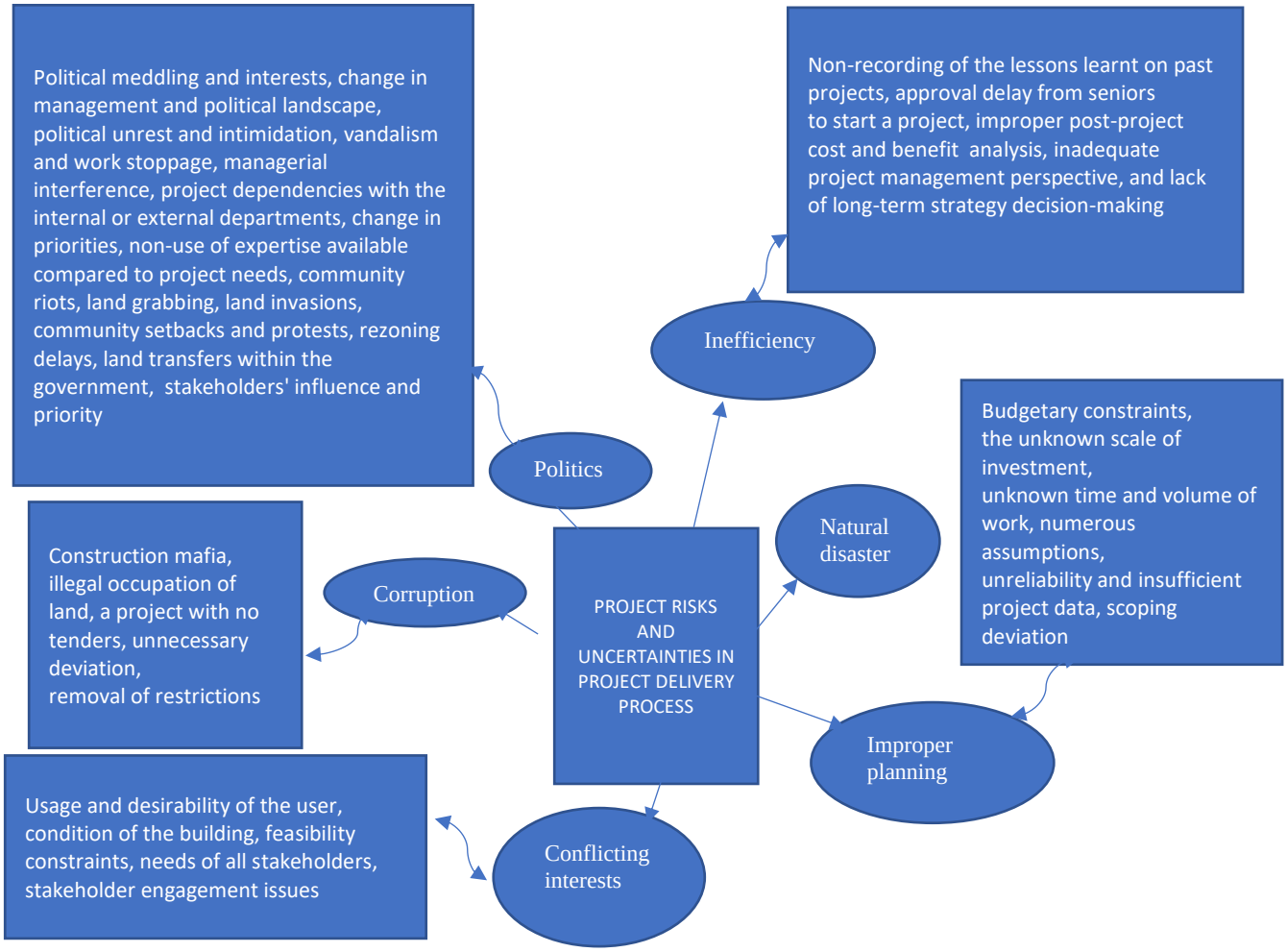

Figure 1: Theoretical framework of project risk and uncertainty in the project delivery process

The inefficiency of the project team members in the delivery processes and the lack of proper project planning on the part of the project managers and organisations are also capable of causing risk and uncertainty in the project delivery process. The causes of project risk and uncertainty, as conceptualised by Blyth [41], provide strong support for the findings of this study. Blyth [41] conceptualised macroeconomic, political, and force majeure risks as the causes of project risk and uncertainty in the project delivery process. While there are similarities between a force majeure and a natural disaster, the concept of macroeconomic risk is slightly different from corruption and inefficiency, as presented in the findings of this study [41]. This indicates that this study offers new findings on project risk and uncertainty in the project delivery process. Although the finding is new, it also builds on the evidence provided in the literature. For instance, studies [33, 41-45] have reported that inability to make an optimal choice among alternative actions, project delivery methods, stakeholders' dynamism, size and uniqueness of projects, the inconsistency of information, lack of risk-sharing, unknown scale of investment, unknown time and volume of work, and numerous assumptions, are all project risks and uncertainties in the project delivery process. The project

risk and uncertainty identified by these various studies align with this study's findings. Figure 1 describes the dynamic interaction of these aspects of risk and uncertainty in detail.

Importance of SAP-PPM as a mitigation tool for project risks and uncertainties

Figure 2 shows a theoretical framework derived from the grounded theory analysis, which explains the importance of SAP-PPM as a mitigation tool against project risk and uncertainty. The framework explains that SAP-PPM is essential as a risk mitigation tool because it supports the development of risk mitigation plans and a risk register. It also supports the review and assessment of risk mitigation plans. The concepts that reflect the importance of SAP-PPM as a risk mitigation tool are presented in Figure 2.

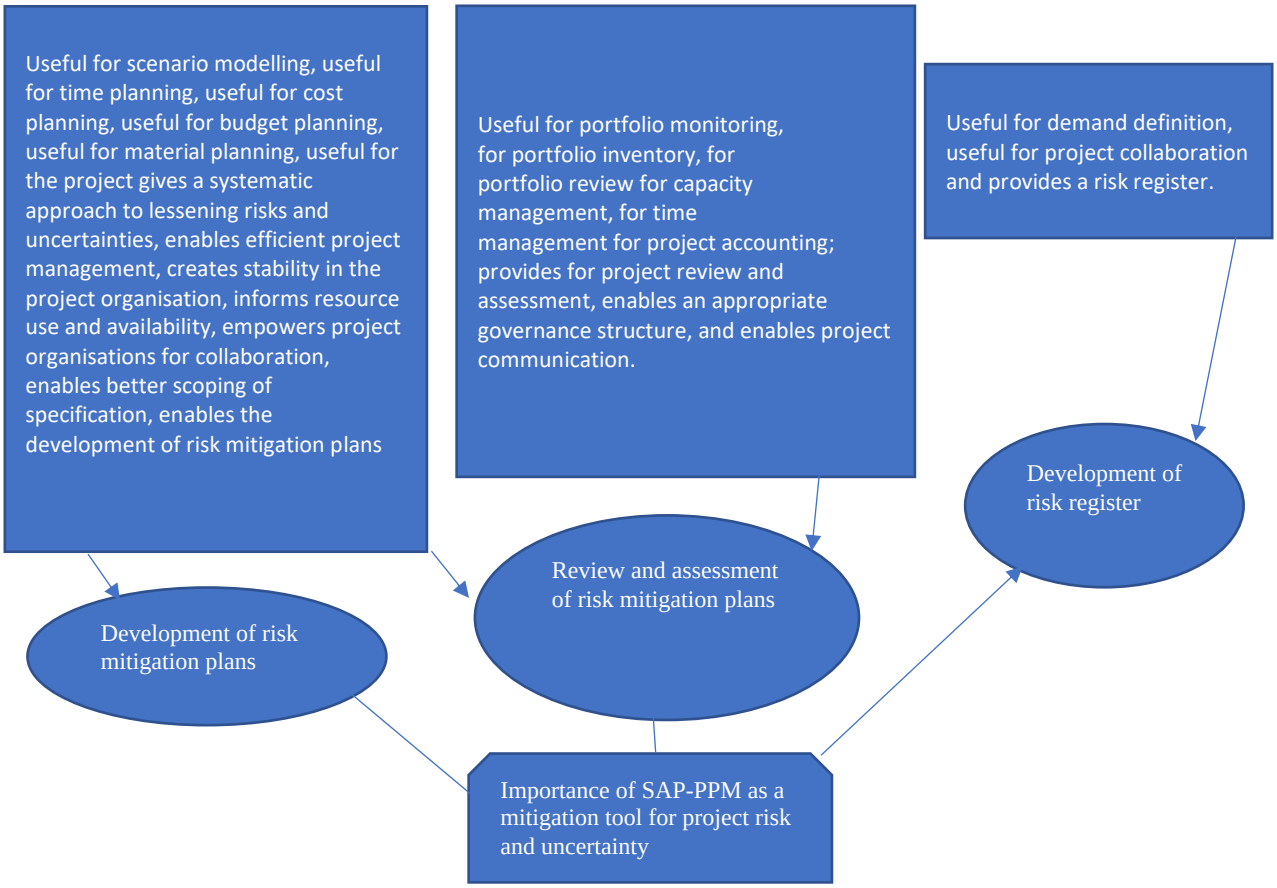

Figure 2. The theoretical framework of the importance of SAP-PPM as a mitigation tool for project risk and uncertainty

As found in this study, developing a risk mitigation plan is important because it enables the preparation for risk mitigation through risk identification, analysis, and measures to lessen the negative impact of the identified risks. This means that SAP-PPM is useful for risk mitigation measures such as scenario modelling, time planning, project scoping, and scoping of the specification. The risk register, however, is essential because it is useful for demand definition and project collaboration. It serves as a record of the identified and likely risks. It makes known the severity and priority of the risks. With the risk register in place, a project

stands a good chance of surviving risk and uncertainty. Also, with the use of SAP-PPM, this becomes easier to achieve.

Conclusions and Recommendations

This study evaluates the effectiveness of the SAP-PPM system as a tool for mitigating risk and uncertainty in the project delivery process. The study findings suggest that the SAP-PPM is a highly effective tool for reducing and mitigating project risk and uncertainty in the project delivery process. In terms of theoretical insights into the nature of project risk and uncertainty in the project delivery process, this study adds a novel contribution to the classification of project risk and uncertainty. The study provides evidence that project organisation corruption and the project team members incapability are project risks. The study delivers a new perspective on how project risk and uncertainty lead to litigation, stakeholders' dissatisfaction, and project delay. The consequences are the failure and abandonment of projects and a bad reputation for the project team members.

Findings revealed that SAP-PPM enables risk identification, risk analysis, scenario modelling, portfolio monitoring, project governance, and project accounting. These processes support risk mitigation. The theoretical categories of the features and functionalities of SAP-PPM reveal that the tools available in the SAP-PPM system qualify it as a practical resource for project management. Finally, an emergent theory was identified, substantively explaining that using SAP-PPM in the project delivery process positively impacts project risk and uncertainty because of its usefulness for resource allocation, priority setting, and timely project performance monitoring. Therefore, the study recommends using SAP-PPM to enhance the opportunities and strengths of the project delivery process. As qualitative research approach has been adopted, the study can form a framework for questionnaire survey to examine the statistical generalisation of the findings.

A limitation of this study was the need to adhere to the governance framework based on the portfolio management standards of the City of Cape Town. Other limitations were the adherence to the time and scheduled standards for City of Cape Town managers, administrators and councillors to receive training in the SAP-PPM system and the lack of evaluation of their understanding. Consequently, further studies can be based on a different project governance framework to the one adopted in the current study.

The research is significant as it has contributed to analysing the efficacy of the SAP-PPM system being used by the City of Cape Town in managing risks on projects. It has also contributed towards identifying and analysing the effects of implementing the enterprise resource planning system, SAP, as a management tool. Besides these outcomes, the research also found that the SAP-PPM information system was workable and valuable for the organisation. Understanding the application of the SAP-PPM system could help managers working within the different project departments at the City of Cape Town and other organisations (both in the private and public sectors) deal with risk and uncertainty in the management of projects.

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