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## Scientific Paper

*Towards the effective management of project risk  
in complex projects: A case study review*

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## Towards the effective management of risk in complex projects: a case study review

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### Abstract

Project Risk Management (PRM) is widely recognized as an essential part of project management practice. However, despite the many PRM standards and techniques, projects still fail to meet our expectations, continuing to run late and over budget. Especially within complex projects, it seems to be a major challenge to ensure that the process for risk management is both efficient and effective. In this article, the findings of an explorative case study on the application of PRM within the Marine Contracting Industry are presented to identify key areas of congruence between theory and practice. Findings indicate that it is essential to adapt generic PRM methods to the particular project or organizational context. Within complex projects, implementing PRM effectively requires a balance between centralized and decentralized activities. Communication, commitment and rigorous control are essential to address the cultural barriers that hamper PRM application, as the process for managing risk needs explicit drivers to work properly.

*Keywords:* Project risk management; Complex project; Effectiveness; Marine Contracting Industry; Case Study

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### 1. Introduction

Risk management is widely recognized as an essential part of project management [9][23][30][25][3], where it can assist the project manager to mitigate both known and unanticipated risks. Project risk management (PRM) has been identified as one of the critical factors in project success [7], supporting the notion that “unmanaged or unmitigated risks are one of the primary causes of project failure” [37][22]. With the growing size and complexity of today’s projects [31], the continuous and systematic management of project risks has become increasingly important. Consequently, risk management receives a lot of attention and is thoroughly studied and propagated by research institutes and risk practitioners. Over the years, this has resulted in the development of a large variety of PRM standards, processes, tools and techniques, demonstrating a common awareness and acceptance of the need for the explicit management of project risk [33].

However, despite the many PRM standards and techniques, research indicates that projects still fail to meet our expectations, continuing to experience significant schedule and cost overruns [13][26]. Recent studies have argued that this at least partially stems from the fact that very few organizations seem to practice and implement project risk management, let alone do so effectively [39][8][32]. A longitudinal project management study over the years 1998-2003, initiated by the Project Management Institute (PMI), shows that organizations consistently fail to apply risk management across projects [28]. Empirical results from a study among 142 project managers indicate that PRM is the least applied PM practice across a large variety of industries, independent of the project’s context, size or duration [31]. Other studies within the Construction industry [21][4] IT project sector [39], [23][22] and Utilities sector [40][12] confirm these findings, giving that there exists an apparent gap between the theory and the effective application of PRM in practice. In spite of the well-established PRM processes, many project

managers perceive their application as ineffective [22][26], pointing out that risk management is not producing the expected and promised results [29].

The tensions between growing project complexity and the difficulty to perform risk management in practice clearly illustrates the potential for exploring and enhancing PRM methods. However, there has been little research on how project managers actually apply risk management on complex projects and which aspects of effective PRM are currently the most lacking [39]. The research reported in this article involves an in-depth exploratory case study of PRM within the Marine Contracting Industry, where market dynamics, technological innovations and a shift of risk responsibility from client to contractor illustrate the growth of project complexity and need for more effective RM practice [3][5]. The case study focuses on comparing the current PRM approach with literature in order to identify key areas of congruence. Accordingly, the article does not add to the theory of risk management. Rather, the aim of the case study is to provide additional insights on the factors that hamper PRM effectiveness in complex projects, as well as creating a better understanding of the relative use of PRM practices and the effect of a particular context on such use. The article will start with a brief description of related literature on PRM, as well as assumed limitations from recent research studies. Then, the case study will be presented and examined. Next, the most important research findings will be presented and discussed. Finally, some conclusions will be made that add to the debate on how to ensure effective PRM in complex projects.

## 2. Review of PRM literature

This section presents some related literature on the management of project risks. First, the PRM concept is presented. Next, the perceived limitations of current PRM standards and processes are examined from recent research, providing a starting point and focus area for the case study review.

### 2.1 The concept and implications of RM in projects

A project is a “vehicle of change” including a unique scope of work which needs to be delivered at a defined time and agreed cost [2]. Consequently, all projects are risky as risk arises from the interaction between predefined objectives and the future’s inherent uncertainty [16]. Thus, PRM has always been present in some form or another, perhaps taking place in informal discussions, our mental calculations or sometimes even as part of our gut feel. However during the past decades, PRM has rapidly

developed as one of the key disciplines of project management, giving the application of formal and systematic methods to cope with project-related risks. Institutions such as the Project Management Institute (PMI) and the Association of Project Management (APM) promote the use of PRM as a key discipline of project management, defined as “*a process which enables the systematic management of risks associated with a project*” [1]. Within this process, several steps, tools and techniques will help the project manager to maximize the chance of achieving project success. PRM assists in making an optimal choice among alternative actions, taking future events (risks) into account that have the potential to affect project objectives. A project risk is defined as “*an uncertain event that, if it occurs, has a positive or a negative effect on the achievement of one or more project objectives*” [18]. Consequently, the traditional view of PRM is concerned with the systematic and continuous planning, identification, analysis and treatment of project risks [23].

The rapid advancement of technology and globalization has fueled the use of PRM across a variety of industries, resulting in a growing number of books, guides and standards that prescribe how organizations should manage their risks. Various (inter)national standardization bodies and professional organizations have developed specific RM standards, however there is no global PRM standard [3], [4][17]. Comparative studies of RM standards suggest that there are only minor differences when it comes to the general structure of the risk process, as all PRM processes follow the same steps [36][11]. Everyone agrees that for the development of appropriate responses to risks, one will first need to identify and assess these risks on their relative significance. However, the identification, assessment and treatment of risk only make up the start of a PRM process, e.g. the “*first risk assessment*” [18]. Because one not only needs to develop a list of risks and responses, but will also have to actually “*manage*” the development of these risks and the implementation of these responses as the project proceeds. Thus, PRM is a continuous process, as today’s projects are better described as “*journeys of exploration in a given direction, rather than strict plan-followed endeavors*” [30]. The dynamics of both the project and its environment require effective mechanisms to ensure that one moves risk analysis to actually taking proactive action in practice.

### 2.2 Limitation of current PRM literature

Although it appears that PRM is a mature discipline, the field is constantly developing as there is still some

way to go before its full potential is realized [29], [17], [33]. In principle, there is nothing wrong with PRM as the general process is well defined, proven techniques exist and there are various tools to develop PRM knowledge and skills. However, the main problem to perform effective PRM lies with the implementation of the process and techniques in a practical situation. Many organizations recognize that systematic and continuous PRM can increase the chance of project success, but they often indicate that its application comes at a certain cost, while it does not directly generate project results. Hence it is crucial that the PRM process is both effective and efficient, making sure that the available resources are put to an optimal use. People will only spend extra time and effort on PRM if it is effectively (addressing their most important risks) and efficiently (no waste of time) applied.

This dilemma is particularly present in complex projects and organizations that are made up of several sub-projects and sub-teams that have to work together as a coherent whole [43]. On one hand, if PRM is implemented at a central level (e.g. by the project manager or project management team), effectiveness of the process may be threatened since specific knowledge on the potential risks and their required responses lies at a lower level of the organization. On the other hand, if PRM is carried out in a distributed fashion, for instance at sub-project level, many project members ought to be involved, implying the need for additional efforts to co-ordinate all the decentralized activities. Getting the support structure for the risk management process right is critical for RM effectiveness, but quite difficult to perform on complex projects [43]. Too little support will make the PRM process ineffective, while too much RM infrastructure can be overly bureaucratic and thereby reduce its perceived benefit. It is therefore essential to adapt PRM to the particular project or organizational context in which it is applied, ensuring that the level of implementation is appropriate and affordable [18].

Current PRM standards lack a well-defined approach to identify and fit the appropriate level of RM implementation to the project's risk profile and organizational structure [18]. Research indicates that PRM standards express significant differences when it comes to the inclusion of elements that ensure the process is adequately controlled, reviewed, communicated and reported upon throughout the entire project lifecycle [36]. Empirical studies indicate that RM is often perceived as a specialist activity or bolt-on extra, rather than being fully integrated with the project's management processes and organization [17], [40], [3]. Hence, it often remains unclear how one should organize PRM to make sure that

risks are actually *managed* by those who are best placed to do so. This study therefore focuses on the issues that hamper the effective implementation of PRM in a complex project, exploring the need for a balance between centralized and decentralized RM activities. Thereby the study aims at identifying important context-related factors that influence the application and effectiveness of the PRM process.

### 3. Case study

#### 3.1 Method

It is difficult to gather quantitative data on PRM, as risk and the management thereof are both multidisciplinary and highly context-related concepts. Accordingly, case study research is chosen as the desired approach as it has the capacity to offer situational and interrelated descriptions of a problem [44]. This makes it possible to connect practical events to theoretical abstractions, while maintaining a strong relation with reality [38]. The case study focused on the analysis of PRM in a complex project situation, aiming to create a better understanding of its application. In particular, the case study focused on the practical implementation, rather than simply reporting what the PRM procedures indicate that should be done. This distinction is important to create understanding on the specific factors and contextual elements that influence the application and effectiveness of the PRM within a specific context.

#### 3.2 Case study company

The case study involved a Dutch company within the Marine Contracting Industry, specialized in offshore platform installation, transportation and removal. Marine Contractors perform the most challenging projects in the world under dynamic conditions. The nerve to explore new opportunities, stimulate innovation and take on record breaking projects is crucial to survival within this industry, stressing the importance of effective PRM methods.

Currently, there is a trend of shifting the risk responsibility from the client to the contractor [3][31], as large marine contractors start taking on the role of "*prime contractor*". In such projects, the contractor takes on the responsibility of managing the entire supply chain of the project for a much larger scope of work. This has resulted in a new era of mega projects [31], where the bets are bigger, stakes are higher and risks are greater. The financial crisis further emphasizes the importance of effective PRM within this sector, as many investments in

the offshore market are postponed and profit margins are rapidly shrinking.

These developments have elevated the importance of a relatively new market area within the Marine Contracting Industry: the offshore removal market. The first and second generation offshore facilities installed in the North Sea during the '60s and '70s are quickly passing into retirement [10]. However, the success of these projects is affected by many risks and uncertainties. Currently, the entire industry is still relatively inexperienced when it comes to the removal of the giant platforms located in the Northern North Sea. The case study performed in this research focused on two of the world's first EPRD (Engineering, Preparations, Removal & Disposal) projects, where the contracting company took on the responsibility for the complete removal of 10 offshore oil platforms located in the Northern North Sea. These projects are both innovative and complex, characterized by their duration of 3-5 years and budgets of over a 100 million USD. Each EPRD project consists of various interrelated subsystems, parallel processes and an extensive project organization that is both horizontally and vertically segregated. External subcontractors further increase the complexity within these projects, adding the issues of conflicting goals, expectations and interests. Furthermore, the development of new concepts and innovative technology contribute to the project's heightened risk profile. Complexity within a project is about the level of understanding of project subsystems, affected by the innovative character of those subsystems and their interactions [5].

It should be noted that the case study presented in this article does not add to the *theory* of PRM, rather its purpose is to document rich case study material on the application of PRM within a complex project. The selected EPRD projects provide an interesting case to explore the gap between PRM theory and its application in practice. This creates a better understanding of the issues that influence the effectiveness of PRM in practice, giving important implications for the improvement of PRM methods.

### 3.3 Data collection methods

The case study was based on semi-structured interviews with project management professionals. The respondents included project directors, project managers, a managing director responsible for project management, risk coordinators and other participants of the PRM process. During the interviews, a rich picture of the PRM process and its application in practice gradually evolved. In total, 22 persons from the organization were interviewed in both explorative and reflective interviews.

Three main questions were asked and discussed during the case study interviews, which were scheduled to take 2 hours:

- How is the project specific risk management process applied when coping with project risks and uncertainty?
- How are the responses to risk implemented, controlled and reviewed throughout the entire project lifecycle?
- Which factors influence the effectiveness of the PRM process and its implementation in practice?

In addition, project specific management plans, procedures and organizational documents have been studied to create an insight into how the PRM process had been integrated within the overall PM system. Specific RM documents such as risk registers, quantitative risk analysis outputs and risk workshop sheets were analyzed to compare PRM outputs with findings from case interviews. By triangulating different sources of information, subjective bias has been ruled out as much as possible. Finally, the case study findings were reviewed and reflected upon by experts to further reduce bias within the study's results.

## 4. Case study Findings

### 4.1 General observations

Respondents were questioned about how they managed risk, whether it was effective from their point of view and what difficulties they encountered in practice. All respondents considered the management of risk a very important part of project management, however they expressed different views on the concept of explicit PRM. Many indicated that in essence, project management is risk management, thus that it is the full responsibility of a project manager to cope with project-related risk. Accordingly, the formal risk procedure implemented in both the tender and project phase merely focused on identifying, assessing and documenting risks. The actual management of risks through the implementation of responses and actions fell under the tasks of the project's manager, which had not been explicitly integrated with the PRM process. Hence, respondents argued that in many cases the risk management process was used to create "risk awareness" at the start of a project, while conventional PM practice quickly took over as the project proceeded. This implies that the PRM process was not necessarily used to support decision-making throughout the entire project lifecycle, but merely functions as a "watch list" under the control of the project's manager. Furthermore respondents often started to talk about the management of "risks", while in



fact they implied the management of the “risk” that a known problem would turn into a crisis, referring to crisis management rather than PRM. Hence, it was not always recognized that a risk is considered to be “*an uncertain event*” that might or might not happen, and that the management of risks is about taking proactive action rather than reactive response. One project manager indicated that “*risks are the things you can’t control*”, expressing a passive rather than active stance towards the management of risk. Another noteworthy observation is that there are several risk management processes and activities that take place across the project’s organization, which had not been fully integrated. Accordingly, separate processes for the management of safety risk, financial risk, schedule risks, weather risk and overall project risk were identified. Respondents indicated that during the Tender and Project Phase there exists separate processes for the management of risk (using a singular PRM procedure) and that these are not explicitly connected. In fact, the PM team made their own independent risk assessment when they actually started the project work. As a consequence, it was not clear which contingencies and risk treatment actions were already included in the project’s budget and schedules. Project planners included slack in their planning, cost estimators estimated contingencies in their budget and the safety department made up the procedures to minimize operational risks. However, these were not documented, analyzed and controlled through a singular PRM system, implying the possibility of duplication and the lack of a common approach to the management of project risk. The research set out in this article continues with a focus on the PRM process applied during the Project Phase, e.g. when the project has been awarded to the contracting party.

#### 4.2 Approach to management of project risk

From the case study analysis, it can be seen that a standardized risk management procedure is used for all tenders and projects, which is facilitated by an internal risk coordinator who is part of a central department for the management of project risk. The process starts with a single risk workshop of approximately three hours in which all project risks are identified, assessed and mitigated. During the workshop, risks (both threats and opportunities) are identified using a phased brainstorm, attended by several internal project team members. Next, risks are described and assessed in small groups of three on a qualitative scale for both probability and impact. Finally, mitigation actions are identified and a person or entire department is tasked to implement these actions. All the risk information generated during the risk

workshop is entered in a risk register which is developed and maintained by the risk coordinator.

For each project, both qualitative and quantitative risk analysis are mandatory. After the risk workshop, the respective project manager quantifies the most important risks specifying a certain probability distribution and perceived risk impact in the risk register. Next, the risk coordinator uses a spreadsheet based Monte Carlo model to calculate the overall “project risk footprint”, providing a scatter plot of possible project outcomes. The output of the quantitative risk analysis is defined in terms of the 10%, 50% and 90% probability of the project’s total duration and cost. The PRM process outputs are communicated through a single project risk register, which is distributed and controlled by the project’s manager. Risk mitigation measures or actions are instigated, monitored and controlled by the project manager, who is fully responsible for the management of all project risks. In compliance with the risk coordinator, the project manager updates the risk register every three months and reports the top 10 risks during internal project progress meetings.

#### 4.3 Application of PRM within complex EPRD projects

On the EPRD projects, that have been analyzed within the case study, the standard PRM procedure of the company has been applied. Accordingly, there have been no additional efforts to fit the PRM process and the use of different RM techniques to the project’s specific risk profile. During the risk workshop, no risk structuring techniques, checklists or other analytical risk identification techniques were used to create a complete image of the project’s risks. Thus, the identification of project risks completely depended on the perspective of the people that were present at the risk workshop, indicating that a workshop with only engineers might create a rich description of technical risks but fails to identify important risks from other project areas. External project parties, subcontractors and operational personnel were not included in the risk management process, while they all had an important stake in the project’s risk profile and the management thereof. The workshop focused on identifying both negative risks (threats) and positive risks (opportunities), however the risk register showed that less than 10% of the 120 identified risks are in fact opportunities. This indicates the tendency to perceive risk negatively, as people more easily associate risk with a potential hazard instead of an uncertain event that might be beneficial to the project’s outcome.

Generally, less than 50% of the identified project risks had an explicit and documented response or action for their management. Not to mention that most of these

responses were very cryptic and vague, giving no clear implication of whom, why, how and by what means project risks are addresses proactively. Only few risks were assigned to a specific “risk owner” who in theory ought to be the best person within the organization to manage the risks. In fact, after the risks had been listed in the risk register, the project’s manager is the single person responsible for developing, assigning and monitoring the implementation of specific risk response actions. Thus, it remains unclear which actions have actually been developed and implemented to proactively treat the perceived risk. The PRM process within the case projects does not incorporate a check or review of the implementation of risk responses, neither is it clear why risks are excluded from the risk register as the project proceeds. This indicates that most risks are still managed in an implicit manner and that the PRM process fails to make sure that risks are managed proactively. The actual management of risks depends for the greater part on the perspective, vision and approach of the project’s manager, expressing a highly centralized and hierarchical approach to the management of project risk. However, within a complex project organization, detailed knowledge on risks lies, to a large extend, outside of the project’s management team [15].

#### *4.4 Factors influencing PRM effectiveness*

Although not prioritized in terms of importance, the study found several factors that influence the effective implementation of the RMP in practice.

First of all, respondents stress the need for more variability in the PRM process, as for the more “simple” projects the process is perceived as “bureaucratic” or “boring”, while for the more complex and high-risk projects far more resources, efforts and rigorous controls might be needed. Hence, it is argued to determine the required focus and level of risk management application in advance. This creates a process that makes efficient use of the project’s limited resources, while providing sufficient time for the rationalization, categorization and allocation of risks to ensure the process remains effective.

Secondly, the current PRM process applied in complex EPRD projects is highly dependent on the project manager’s competence, as he/she is considered as the project’s main risk manager. Respondents indicate that the PRM effectiveness depends for a great deal on the manager’s familiarity and expertise in using PRM techniques, and his/her ability to promote the application of proactive PRM throughout the project’s organization. Accordingly, some managers perceive the PRM process as an integral part of their daily activities and use risk information in a structured manner to support decision-

making. Others adopt more of a “tick-in-the-box” attitude towards the management of project risk, taking on the general perception that PRM is a bolt-on extra. This indicates the strong influence of a manager’s personal attitude towards risk to affect PRM in practice.

Thirdly, respondents expressed the importance of effective mechanism for communication, control and commitment to proactively address risks in practice. When risks are not properly described in terms of their perceived source (uncertainty) and effects on project objectives, it remains very difficult to develop effective response actions. Next, if there is no clarity on the relative importance of risks and who should take responsibility for their management, reality often shows that nobody does. Hence, it was argued by respondents that assigning risks to a single individual who is best placed to manage the risk is crucial for PRM effectiveness. This also makes it possible to check which response has been chosen, which actions have been developed and how they are perceived to change the impact of the risk when implemented. Because project managers indicated that if nobody checks the results of the PRM, risks are often identified and then easily forgotten throughout the project’s lifecycle. Hence, project risks are solely listed within the project’s risk register, but not addressed until they actually occurred and developed into problems. Furthermore, this makes it very difficult to monitor and evaluate the actual results of the PRM process.

## **5. Discussion**

Findings from the case study review will be discussed in terms of PRM literature, PRM standards and recent empirical research on the application of PRM in practice. Three areas that influence the effectiveness of PRM in complex projects are discussed, providing a point of departure for improving current PRM practice.

### *5.1 Varying Depth and Breadth of PRM*

The first step in current PRM standards focuses on laying out the groundwork for all RM activities: PRM initialization [33], [15], [36], [17]. For PRM to be effective and efficient, the specific scope and level of RM implementation has to be determined. This requires all project stakeholders to discuss and answer the questions of why, what, when, who, how and for whom risk management is to be implemented, taking into account the perceived risk profile of the particular project. Accordingly, these issues should be documented in a project-specific Risk Management Plan that includes agreement on the methods, techniques and tools that shall



be used for PRM, who is responsible for the application of PRM and which scope of risks shall be considered [18], [15]. Empirical studies however show that in many cases there is no project-specific Risk Management Plan [31]. A detailed analysis of PRM in IT projects concludes that there had been “no indication that respondents varied from prescribed procedures” [39], as can be concluded from the case study review described in this article.

Risk professionals point out that by varying the overall RM approach and techniques within them, one could make PRM more exciting and therefore effective [29]. One of the recently published guides on how to perform risk management in practice explicitly addresses the issues of scaling PRM to a specific project, e.g. the ATOM methodology [18]. In response to the great variety of projects, the ATOM methodology is one of the first PRM processes that offers a scalable risk management process, recognizing that simple projects may only require a simple risk process, while for complex project PRM needs to be applied with more rigor and discipline [18]. However scalability of PRM is provided through the number of risk reviews and the use of specific tools and techniques, thereby extending the “breadth” of PRM application to the project’s size (e.g. small, medium or large). However what seems to be lacking is a scalable approach that addresses the “depth” of PRM implementation within a complex organization. Accordingly, it remains unclear what should be the optimal level of PRM application in a complex project. Because effective PRM is not only about using the right tools and techniques, but also about including the right people within the process and dividing clear roles and responsibilities for the efficient organization of PRM. Improving PRM effectiveness therefore requires the development of a comprehensive framework to fit specific roles and responsibilities for managing project risks to the project’s organizational context.

### 5.2 Centralized versus decentralized PRM

From the case study review, it can be seen that many respondents see risk management as the responsibility of a centralized risk manager, e.g. the project manager. This notion is confirmed by recent research, stressing that in most cases “risk management adherence is dependent on the project manager” [30]. However, this implies that PRM effectiveness depends heavily on the skills, experience and management style of this particular person. Other empirical studies point out that “risk responsibility assignment” is one of the most effective RM tools [34] and that the adequacy of assigning specific “risk owners” is considered one of the most influential

factors in PRM success [8]. However, what seems to be lacking in current practice is an open, clear and explicit system that encourages all project members to participate in the PRM process, creating a collective responsibility for managing risk.

Studies that address the issues of complexity and PRM implementation indicate that the concepts of empowerment of sub-project teams and a centralized PRM system are essentially in conflict [42]. On the one hand, a centralized PRM perspective is necessary as project risks are heavily connected in complex projects, indicating that separate project teams understand less of the impact of their decisions on the project as a whole. But on the other hand, detailed knowledge on potential risks lies at a lower level of the organization as it is no longer possible for a single project manager (or PM team) to oversee all project risks and control their management. Thus, what is needed is an appropriate combination of centralized and decentralized PRM activities, where sub-teams and specific risk owners are responsible for analyzing, assessing and managing their own risks [24], while at the same time information is gathered through a central PRM system to support decision-making on a higher management level. Hence, improving PRM effectiveness in complex projects requires addressing the interface of a central PRM framework that explicitly allocates risk responsibility to the various sub-project teams and risk owners.

### 5.3 Reactive versus proactive response to risk

From the case study findings it can be seen that in many cases people only become active when risks have already turned into real problems. In most projects, people are busy performing their normal tasks and are therefore less prone to take proactive actions to future events. There is always a chance that a risk might not occur, making it hard to spend additional resources in advance. Many empirical studies on the subject of PRM practice show that managers often believe they are managing risks proactively, while they actually find themselves reacting to problems which have already materialized [40][35]. Other studies indicate that there exists a tendency in the construction and facilities management industries to leave risks, let them grow and react to them when they have occurred, rather than preventing them from happening in the first place [24].

A simple explanation for the fact that people often fail to take proactive action is given by “the hero concept” [29], stating that project managers who get the most praise are those who turn problematic situations into a successful outcome. However, there is often little

attention devoted to why the project got into trouble in the first place, let alone the ability of the project team to effectively plan and address project risks in order to avoid such a situation. Hence managers that have spent most of their efforts on solving problems are seen as the company's heroes. While those who practiced effective PRM and deliver their projects on time and within budget receive the comment "it must have been an easy project anyway" [29].

A recent study on the management of uncertainty in complex IT projects shows that there are several "barriers to proactive action" which cause ineffective PRM of project managers [36]. The barriers stem from the denial, avoidance, delay and ignorance of uncertainty. People either refuse to reveal risk related information to other stakeholders, share a lack of attention to PRM, fail to resolve risk issues due to apathy or show a complete lack of risk awareness. It is therefore argued that PRM needs explicit drivers to function properly, appointing someone within the organization to address these barriers that hamper PRM implementation. For the improvement of PRM in complex projects, one needs to ensure that actions and responses are implemented with enough rigor and vigilance. Assigning explicit "risk champions" to provide the required support and control is therefore considered an important aspect of effective PRM practice.

However, it should be noted that "no matter how good risk management processes are, projects will invariably face unexpected events" [13]. Hence, preventive methods alone are not enough to develop successful projects. Several studies point out that planning is necessary, but one can never identify all risks using even the most effective RMP process [18], [13]. However, PRM can create simple, responsive and effective structures to deal with unexpected events as they emerge. Thus PRM will not always produce correct decisions, but it will support management in making better decisions to increase the chance of achieving project success.

## 6. Conclusions

The objective of this article was to explore the application of PRM practices within a complex project situation. Accordingly, the current PRM practice within the Marine Contracting Industry has been explored in a case study review. Results show that there are many PRM standards, processes, tools and techniques supporting a widely-accepted PRM methodology. However, the task of developing and implementing an effective PRM process in a practical situation seems far more difficult. Within a complex project, it is crucial to ensure that the PRM

process is both effective (addressing the most important risks) and efficient (optimal use of resources). Three areas that influence the effectiveness of PRM in complex projects were identified, providing a point of departure for improving the application of PRM in complex projects:

- PRM needs to be scalable to fit the particular project or organizational context in which it is applied, ensuring that the level of implementation is appropriate and affordable. The initialization of PRM is essential to make sure all project parties agree on the desired PRM scope, focus, roles and responsibilities. One will not only need to vary the "breadth" of the PRM approach by changing the number of risk reviews, tools and techniques that are applied, but also develop a comprehensive framework to integrate the PRM approach with the project's organizational structure, varying the "depth" of PRM application.
- A major challenge in implementing PRM within a complex project lies in finding a balance between centralized and decentralized PRM activities. In order to find such a balance, one needs to develop a system that explicitly divides risk responsibility to the project's sub-teams and risk owners, while at the same time collects and communicates relevant risk information to support decision-making on a central level.
- Within complex projects, explicit control and support of PRM implementation is required to address the barriers that hamper PRM implementation. People should be stimulated and rewarded to take preventive actions in reducing project risk, rather than reacting to problems as they emerge. Consequently, the risk management process needs explicit drivers to work properly. Appointing a risk champion to facilitate, control and stimulate proactive RM is considered to be a vital element of effective PRM practice.

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