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THE USE OF RISK REGISTERS BY PROJECT MANAGERS

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The construction industry is widely recognised as being inherent with risk and uncertainty. This necessitates the need for effective project risk management to achieve the project objectives of time, cost and quality. A popular tool employed in projects to aid in the management of risk is a risk register. This tool documents the project risks and is often employed by the Project Manager (PM) to manage the associated risks on a project. This research aims to ascertain how widely risk registers are used by Project Managers as part of their risk management practices. To achieve this aim entailed interviewing ten PMs, to discuss their use of the risk register as a risk management tool. The results from these interviews indicated the prevalent use of this document and recognised its effectiveness in the management of project risks. The findings identified the front end and feasibility phases of a project as crucial stages for using risk registers, noting it as a vital ingredient in the risk response planning of the decision making process. Moreover, the composition of the risk register was also understood, with an insight into how PMs produce and develop this tool also ascertained. In conclusion, this research signifies the extensive use of the risk register by PMs. A majority of PMs were of the view that risk registers constitute an essential component of their project risk management practices. This suggests a need for further research on the extent to which risk registers actually help PMs to control the risks in a construction project, particularly residual risks, and how this can be improved to minimize deviations from expected outcomes.

Keywords: interview, project manager, risk management, risk register, UK

INTRODUCTION

The subject of this paper relates to risk management theory. Risk management comprises of three main tasks of risk identification, risk analysis and risk response (Edwards and Bowen, 1998). One of the common techniques used for logging and analysing project management risks is a risk register (PMI, 2004). Risk registers provide a basis for logging identified risks in order to quantify them on the basis of their probability and impact or consequence. However, it has often been argued that such two dimension evaluation of risks is insufficient for appropriate management action (see Williams, 1996 and Laryea et al., 2007). As such, the associated financial implications and effects to the critical path are often projected as part of this risk reporting. This enables the impact of each risk to be realised in terms of cost and time, delivering focus to the project risks and their related consequences.

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Project Managers perform an important function in construction supply chains. They help to manage resources on site to ensure completion of projects according to time, cost and quality projections, including the management of risks (Isik *et al.* 2009). One of the tools they employ to achieve this is a risk register, which helps PMs to deal effectively with the management of risk (Webb, 2003). As explained above, these risk registers help them to understand the risks that have been identified, priced and apportioned. However, there is little evidence in the literature on how PMs employ risk registers in their work.

This research was carried out based on a study of ten PMs in the UK to understand how they use risk registers within their profession. The scope of this work relates to both the construction and pre-construction phase of projects. However, in future, it may be useful to also understand how risk registers are used by PMs during the completion of the project and ascertain whether the realisation of full risk mitigation was achieved through using a risk register.

PROJECT MANAGEMENT AND RISK

According to Huff and Prybutok (2008), in their study of the way in which PMs manage information systems;

‘problems occur when project management does not recognize the risks of the project and then fails to achieve the goal of shepherding the project toward completion in an acceptable manner, either in terms of elapsed time, accumulated cost, and/or functionality.’ (Huff and Prybutok, 2008).

This holds particular relevance in the field of construction project management due to the invariable complexity of construction projects (Baccarini, 1996). This is also established by Kähkönen (1999), in his research into the multi-character model of the construction project definition process. Here Kähkönen identifies project risk as being one of the contributing factors that has a direct effect on the extensiveness, methods, level of detail and completion time of a project. This in turn necessitates the need for PMs to look ahead in order to plan for unforeseen changes in the project. This is discussed by Reiss (2007) in his book, *Project Management Demystified*. Here, Reiss describes how PMs are ‘continually faced with decisions about the route ahead and must plan for events that are long distant in the future.’ (Reiss, 2007:17). This creates the need for PMs to be familiar with the project environment and the circumstances that may affect the productivity, performance, quality and budget of a project. (Isik *et al.* 2009).

This evident degree of uncertainty is a defining characteristic of risk and as discussed earlier is inherent within the construction process. This is epitomised by Akintoye and Macleod (1997) in their paper relating to the risk analysis and management within construction. Here they note; ‘The construction industry and its clients are widely associated with a high degree of risk due to the nature of construction...’

Consequently, this demonstrates the continual exposure to risk within the industry which Tah and Carr, (2001) believe jeopardises the outcome of projects; ‘The construction industry still suffers from poor project performance due to risks’. Therefore, it is crucial that risk is effectively managed, as it has become a key ingredient towards the completion of construction projects, (Oztas and Okmen, 2004).

RISK REGISTERS

According to Webb (2003:94) in his publication titled, 'The Project Manger's Guide to Handling Risk' a risk register is described as; 'The most popular method of recording and ordering risks...specifying all perceived risks with the outcomes, likelihoods and countering strategies'. This is developed by Laryea (2008:49), in his thesis on Contractor's approach to risk in the tender process. Here the risk register is typified as containing, 'a list of identified risks; list of potential responses; root causes of risk; and updated risk categories.' This understanding of the risk register is progressed by Reiss (2007:179) in his book, *Project Management Demystified*. Here Reiss states, 'A risk register can...discuss at length the nature of the risk, the impact and the things that can be done to prevent or reduce the impact of the risk.' From this literature, it becomes apparent that the risk register is an effective tool that contributes towards project risk management. This is accentuated by Burcar and Radujkovic (2005) in their paper examining the use of risk registers in the Croatian construction industry. Here, Burcar and Radujkovic conclude that the 'application of an adequately structured and designed risk register can significantly contribute to success not only at project level, but also at company level.' This subsequently demonstrates the significance of this risk management tool in a project environment.

As mentioned by Reiss (2007), one of the features of a risk register is to ascertain the impact of each risk. This often requires a form of risk ranking, regularly founded on the probability and severity of an individual risk. This approach is discussed by Baccarini and Archer (2001), in their paper examining the risk ranking of projects. Here Baccarini and Archer state how project risk management literature 'describes the need to rank and prioritise risks in a project in order to focus the risk management effort on higher risks.'

This process of risk ranking is developed by Lambert *et al.* (2001) in their paper, reviewing the identification, ranking and management of risks in a major system acquisition. Here Lambert *et al.* (2001) note how this process is designed to, 'prioritize sources of risk in terms of the likelihoods of occurrence, the potential consequences to the program, and the efficacy and immediacy of risk-reduction efforts.' These factors correspond with the five principles outlined above by Webb (2003). Moreover, Patterson and Neailey (2002) reiterate these points in their paper, discussing a risk register database system to aid in the management of risk. Here the risk register is described as a 'formal mechanism to document the identified risks, their associated probability and impact values as well as their ranking in the project'. This demonstrates a characteristic of the risk register that can deliver focus and prioritisation on the project risks that hold the greatest severity.

In turn, this presents the risk register as a practical tool in the methodology of risk management. This is advanced by Patterson and Neailey (2002) when they state; 'The Risk Register itself is an extremely effective tool to enable everyone involved in the project to consciously evaluate and manage the risks'. As such, this demonstrates that the risk register both promotes and delivers the values of joint risk management to a project, through collaboration and increased awareness of the project risks.

Mwakitalu (2006:80), in his thesis on the risk management process in Tanzanian municipal infrastructure projects, also explains the use and value of a risk register. Here Mwakitalu explains how 'information on risks' source identification, the stage of a project risks are expected to occur and assessment of their likelihood and consequences will be recorded'. Mwakitalu develops the understanding of this

document further in his study when providing an example of a risk register. Through this illustration, the composition of the register with columns for risk identification, risk assessment, risk response and risk monitoring are made clear. These subsequently combine to produce an effective means of managing risk within a project setting.

This suggested use of the risk register within a project environment is ascertained further by The Joint Contracts Tribunal (JCT)-Constructing Excellence Contract Guide (2006:16), through the following statement;

‘The Risk Register is a vital project management tool intended to identify potential risks relating to the delivery and performance of the Project, the probability of those risks occurring and their likely financial and possibly time consequences together with the naming of an individual or organisation who will be responsible for managing each risk. Through regular review of the Risk Register the Project Team will have the greatest opportunity of preventing risks from occurring and mitigating the adverse effects of those that do occur.’ (JCT, 2006:16)

PROBLEM STATEMENT

It is clear from the above literature that the risk register is a highly effective tool and their employment within a project environment plays a pivotal role in the control and mitigation process of project risk management. As such, a need to develop and understand the way in which Project Managers actually formulate and implement this document in practice is required. This will subsequently progress the industry’s comprehension of this management tool, benefitting industry professionals in their management of project risks.

RESEARCH OBJECTIVES

The following research objectives outline what this study aims to achieve;

To identify how Project Managers compose and develop the risk register.

To ascertain the extent to which Project Managers use risk registers as part of their project risk management practice.

To identify the key stages of a project where the risk register has significant importance.

To ascertain the extent to which Project Managers consider the risk register as a contractual document.

To evaluate the significance of the risk register in the project management process.

To address these specific objectives, an appropriate research design and methods was required:

RESEARCH DESIGN AND METHODS

The research design consisted of five stages. Firstly, research questions were developed from an extensive spectrum of literature based around the subject matters of risk, project management and the management of risk. Second, a semi-structured questionnaire was produced in relation to the study objectives. The third step involved carrying out interviews with ten PMs which were transcribed. The penultimate stage was to qualitatively analyse the transcribed interviews, with the final step linking the acquired data to existing studies on this subject and the research objectives. For this study, it was considered necessary to cover a range of firms with organisations being wholly project management or offering this service as an addition to their existing

capabilities. All of the companies approached covered a range of developments in terms of residential, commercial and infrastructure projects. This was considered essential to provide a more indicative analysis on the use of risk registers, throughout the construction industry and project management profession. Ten PMs from seven different organisations with varying levels of experience were interviewed as part of this research. (See Table 2 in the Appendix).

The interview questions used are shown in Table 1 in the Appendix. These questions have been grouped in correlation with the five study objectives. As a result, this allowed a clear and direct link to the objectives, enabling their achievement to be realised.

RESULTS AND DISCUSSION

A summary of the results of interviews with ten PMs are presented in Tables 3-7 in the Appendix. These five tables outline the data obtained in relation to the five research objectives. The summary of these results are expanded and discussed below.

Composition and Development of Risk Registers by PMs

As shown in Table 3 in the Appendix, the first five questions explored the PM's composition of the risk register and how this document is developed throughout the project. From question 1 the PMs' definitions presented the risk register as a tool for identifying the associated project risks produced in a spreadsheet format. This is demonstrated through PM 3's view when revealing; *'it's done always on a spreadsheet'*. This echoes the work of Mwakitalu (2006) who identifies the composition of the risk register as a spreadsheet with a series of sub-divided columns. The understanding of these columns were developed further by four of the PMs whereby the project risk, risk scoring and mitigation measures were noted as forming part of their risk registers. This corresponds with the studies from Webb (2003) and Laryea (2008) where 'countering strategies' and 'potential responses' are identified as characterising features of this document. This in turn highlights a direct correlation between existing literature and the practical application of this document. In addition, PM 1 also detailed columns for a risk owner, action date and differentiation between a time/cost impact within his register. As a result, an understanding of how PMs compose the risk register is understood, contributing to the realisation of Objective 1.

This group of questions also identified the characteristic of colour and visual aid as being an important feature of the risk register. The findings from Question 2 indicate that all of the PMs agreed that the use of colour and pictorial representations was definitely a helpful ingredient in the risk management tool, (see Table 3). This is advanced through PM 8, whom views the integration of colour as *'a very useful feature and it highlights all of the main risks that need to be focussed on.'* In addition to this, it was also found from these responses that the use of a traffic light system of green, amber and red to highlight the level of risk is often employed when differentiating between the project risks. This is an area that current literature insufficiently recognises and is only briefly mentioned by Laryea and Hughes (2008) in their paper discussing how Contractors price risk in the bidding process. Here, Laryea and Hughes note how 'each risk is designated as 'green', 'amber' or 'red'' to identify the level of risk. Therefore, the findings from this research help to develop our understanding of colour and visual aid as an essential component of the risk register.

As highlighted in Table 3, nine of the interviewed PMs noted a risk workshop and brainstorm session as the initial phase of risk identification. PM 5 discusses this process of a risk workshop as a *'brainstorm of ideas...understanding what the key problems are.'* This corresponds with Dallas (2006) in his textbook *'Value and Risk Management, A Guide to Best Practice'*. Here Dallas discusses the widely used method of generating risks during a workshop where *'the traditional technique is to brainstorm the risks to generate a comprehensive list.'* Dallas (2006:315). Therefore, it is clear that the findings from this study perpetuate the techniques detailed in current research. Furthermore, the importance of intuition and experience when identifying project risks was also obtained from these findings. PM 4 notes, *'It is a bit intuitive, it's a bit of experience.'* This subsequently elicits the significance of experience in the process of project risk management and highlights how the risk register is developed by the PM.

In addressing the types of risks fed into a register, it is clear from the PMs' responses that it is dependent upon the context of the project. The PMs did however highlight the generic project risks that are likely to occur. These are presented in Table 3 where time, cost, procurement, ground conditions and weather are frequently noted as key project risks by the ten PMs. PM 8 elaborates on the areas of project risks to consider when stating; *'You start off with things that are sort of well outside of your control, outside your spheres of influence...macroeconomics stuff, legislative stuff...weather.'* It is therefore apparent that there is a wide spectrum of risks to consider, thus necessitating the need for effective project risk management.

The final interview question relating to this objective details the categorisation of the project risks in the risk register. As illustrated in Table 3 in the Appendix, the majority of the PMs did correspond in that they categorised the risks in the register in terms of costs, time, site issues, procurement etc. This classification of the risks is stressed by PM 6 when noting how it *'does help focus the mind'*. Moreover, PMs 1 and 4 detail the importance for the Client in having these categories in place, enabling the identification of cost and/or time as a risk consequence. This in turn broadens the understanding of how the risk register is developed and its composition as a risk management document, realising Objective 1 of this study.

PMs' Use of the Risk Register

To achieve this objective six interview questions were created to understand how the PM uses the risk register in a project environment. As shown in Table 4 in the Appendix, the responsibility for producing the risk register within the project team was firstly understood. The main response to this question found many of the PMs affirming that one of their key duties is to create and develop this document. However, it was also noted that the Cost Consultant plays a key if not pivotal role in the production of the risk register. This was established through the responses of PMs 1, 5, 7 and 9 whom all identified the Cost Consultant/Quantity Surveyor as having input in the production of this document. PM 1 states; *'It's generally in the scope of services of the Project Manager or sometimes the Cost Consultant can establish the risk register'*. As a result, this indicates a variation in the responsibility for developing the register which PM 5 notes as being dependent upon the Client. This in turn validates how the risk register is in place to not only act as a project management tool, but also as an instrument to elicit the financial implications associated with the project risks. This subsequently demonstrates the risk register's value to both the project management and quantity surveying profession.

It was also understood from this area of questioning that the ten PMs considered it general practice to calculate the impact of each risk by multiplying the risk probability by the severity/impact to produce a risk score. The PMs noted that this determines where the risk sits in a risk scoring matrix with the previously mentioned traffic light system being applied. These findings relate heavily with present literature, in particular Winch (2010) from his textbook *Managing Construction Projects*. Here, Winch notes how ‘One of the most popular risk-management-specific tools is the probability/impact matrix’, (Winch, 2010), to allow the prioritisation of the project risks. As a result, this research complements the ideas in existing studies and demonstrates the process of risk assessment in practice as used by PMs.

As shown in Table 4, it was also noted that the risk register is generally subject to monthly reviews by the project team in order to effectively examine the project risks. PM 10 however, details how in practice he reviews the risk register every three-six months and at key project gateways such as the initial cost plan, planning application, tender document issue and tender returns. This consequently, underlines the document’s continuity and prevalence as a tool within the project environment. Moreover, these findings demonstrate how PMs utilise the risk register in the project management process revealing it as a frequently employed document by PMs, in turn realising Objective 2 of this study.

As shown in Table 4, the responses obtained for Question 9 presented the general consensus of the PM and/or the lead designer as having ultimate responsibility for assigning an individual owner to managing a risk. PM 6 explains, *‘The Project Manager is responsible for the project risk register, for determining who is best placed to manage that risk.’* This is synonymous with PM 2 when he states; *‘as Project Managers we’ll oversee the whole process’*. This verifies the PM as having a crucial position in the management of the project risks and stresses the need for PMs to effectively implement and utilise techniques such as the risk register as an aid in the risk management methodology.

In addition to this topic of risk responsibility, the PMs did all concur in viewing the project risks to have one owner but be collectively managed by the project/design team. This is affirmed through PM 3 in his response; *‘it should be a team thing but there will be an individual that has particular responsibility for a certain risk’*. This collective input from the team is to ultimately ensure the effective mitigation of the project risks and demonstrates the implementation of joint risk management in practice. This joint risk management approach is defined by Rahman and Kumaraswamy (2001), in their research into risk management in the Hong Kong construction industry, whereby; ‘synergising the experiential knowledge, resources and sustained efforts of all major project participants’ is indicative of the joint risk management process, Rahman and Kumaraswamy (2001). As such, it is clear the PM can use the risk register as a driver towards achieving a co-operative approach in the management of project risks, through the assignment of owners, both individual and team.

The final interview question for Objective 2 showed how only three of the ten PMs produced an additional risk register to show an individual activity in more detail (See Table 4). PM 3 explains how on his most recent project;

‘we needed to do a specific risk register for a key bit of kit that was going to go right in the middle of a refinery... we highlighted something that was going to be a big risk

and then we looked to see what the overall risk might be, how we can break that down and how we could mitigate each area of it.’

This response clearly identifies how particularly complex proceedings in a project may require an additional risk register, which PM 1 acknowledges as helping *‘focus the mind’*. This demonstrates how the risk register can be implemented as a management tool that not only identifies the broad project risks, but also offers the ability to evaluate risks in greater detail. This is an area not currently explored within existing studies and reveals an added function of the risk register that can be employed by the PM, realising Objective 2 of this research.

SIGNIFICANCE OF RISK REGISTER IN PROJECT STAGES

This objective examines project phases where the risk register is particularly crucial. The initial findings obtained for this objective indicate how the scale and characteristics of a risk change and develop as the project progresses, (see Table 5). This is epitomised through PM 1 when stating, *‘the risks are always changing...that’s why we have these tools so we can keep track of them.’* Moreover, PM 6 notes; *‘as a project progresses your total risk should reduce’*. Consequently, this identifies the risk register as a live document that is continuously evolving as the project progresses. This is an area discussed by Godfrey (1996) in his guide to the systematic management of risk in construction. Here, Godfrey notes how, *‘As your project progresses, your risk exposure and the relative importance of various risks alter.’* In turn, this shows how the findings emulate Godfrey’s work and signifies the importance of the risk register in monitoring the magnitude of the project risks through the entire project process.

The responses for Question 13 as shown in Table 5, identifies the front end/ feasibility phase of a project being determined as the most influential. This subsequently pinpoints the pre-construction stage of a project where the risk register is particularly crucial. This is strengthened through PM 9 viewing the pre-construction stage as vital in determining whether a project can proceed to construction. This risk evidently holds the greatest severity, thus verifying this point in a project as central on the influence of project risks. As a result, these findings achieve Objective 3 by highlighting this project phase, where a risk register is employed, as particularly significant in the overall project process.

Risk Registers as a Contract Document

This area of questioning examined the degree of confidential information within the risk register and its integration into the contractual documents to a project. Of the ten PMs interviewed seven of them all agreed that the risk register is not held confidentially, (see Table 6). Moreover, the majority of the PMs believed that the register should remain an open document with PM 1 viewing confidentiality as a *‘negative step’* that prevents its purpose of identifying risks, to the project team, being achieved. However, PMs 3, 6 and 9 do indicate that some information should not go outside of the project, thus elements should remain confidential. In response to this PM 9 suggests, *‘a sanitised version of the risk register that’s available, for full distribution and there’s a slightly fuller version that’s kept confidential.’* Examples of these elements were noted by some of the PMs as financial information such as the solvency of a sub-contractor and the Employer’s financial limit on a particular risk. PM 2 notes; *‘It may contain confidential information, especially if it’s a costed one.’* This in turn establishes how this document can hold sensitive information, which PM 3 believes may affect the actions taken by their suppliers and contractors. This

subsequently highlights the influence of the risk register within a project environment, thus perpetuating the importance of this document in achieving project success.

As noted in Table 6, five of the interviewed PMs all said that they integrate the risk register into the contractual documents with PMs 3 and 4 noting how only certain aspects of the register will be included. PM 4 elaborates on this when noting the significance of the project risks on the Contractors pricing of the works. As such, incorporating the full risk register within the contract, according to PM 4, will inflate the Contractor's costs through the pricing of the project risks, thus having a negative effect. In spite of this, PM 7 does stress the importance of the project and Employer, as his involvement with Government projects have specified the incorporation of the full risk register within the contractual documentation. PM 7 notes; '*for the Ministry of Justice they are part of the contract that is issued*'. As a result, it is clear that this topic area is contentious, which is supported through the little literature available on this subject. For example, the Joint Contracts Tribunal (JCT)-Constructing Excellence Contract Guide (2006:17) states; 'Whilst the Risk Register is a project management tool, it does not form part of the contractual documents.' However, within the NEC 3 Engineering and Construction Contract (2005:4) the risk register is defined as, 'a register of the risks which are listed in the Contract Data'. From this it is apparent that the contract itself can determine the extent of the risk registers integration as a contractual document. However, as made clear from the viewpoints obtained from the ten PMs, the general consensus is that the risk register forms part of the contract documents on some level, as all parties to a contract should be aware of the project risks. This is personified through PM 5; '*in terms of the way that we tender jobs then yes they certainly would be a key document that would be included within the contract so the Contractors are aware of what the risks are to the project*'. Therefore, from this research it is apparent that the risk register is included, to some degree, within contractual documents. Although, it is important to make clear that the general standpoint was that no contractual obligations should be attached to this document, as its integration is purely to draw attention to the identified project risks. In turn, this realises Objective 4 of this research and demonstrates the typical procedures of PMs in practice.

SIGNIFICANCE OF RISK REGISTER IN THE PM PROCESS

The final objective of this study addresses the overall significance of the risk register within the project management process. As shown in Table 7 in the Appendix, seven out of the ten PMs all agreed that the risk register is an extremely significant tool in the project management approach. PMs 6, 7 and 9 however, describe the risk register as one of a number of tools that are not entirely intrinsic for the achievement of project objectives. As a result, this elicits a deviation amongst the interviewed PMs in terms of how they value the risk register as a management tool. However, as the majority of the PMs confirmed the register as '*essential*', '*significant*' and '*a key part of approach*' it is clear that this document plays a crucial role in the project risk management methodology. This echoes much of the available literature that presents the register's significance within the project environment. This is supported through 'An Architect's Guide to NEC 3' (2011), whereby the risk register is termed as a '*vital provision*' in efficient project management. These findings clearly accomplish Objective 5 and demonstrate the significance of the risk register as a managerial tool.

Furthermore, in comparison of techniques the findings indicate that eight out of the ten PMs all mentioned the Monte Carlo simulation as an alternative method for

project risk management. However, as seen in Table 7, PM 6 was alone in believing that the Monte Carlo method should be employed at a greater level throughout the industry. The remaining PMs all indicated towards the risk register as being the better risk management tool. Moreover, the general consensus affirmed the register as a straight forward approach that achieves its purpose, as opposed to the Monte Carlo method, that often obfuscates the information produced.

In addition, seven of the ten PMs all agreed that a risk register is an essential tool on every project. This is demonstrated by the following PMs; PM 3; *'Yes...no matter what the project'*. PM 4; *'Yes, on every project no doubt about it'* and PM 5; *'Definitely yes...I think it is a key document to any project.'* Despite this, PM 7 does note how a project can progress without the application of this document. However, as Table 7 illustrates, the main consensus amongst the PMs is that the risk register plays a pivotal role within the project management methodology and is a key document within the profession. As such, it is apparent from these findings that Objective 5 is achieved and the risk register is presented as an essential tool in the project environment.

CONCLUSIONS

The aim of this work was to obtain a better understanding of the way that Project Managers use Risk Registers to manage the risks in a construction project. Ten PMs in the UK were interviewed and the results revealed interesting findings that provide some basis for further research. Five main conclusions are drawn following the results and discussion.

First, the findings for Objective 1 present the composition of the risk register in spreadsheet form and draw attention to the use of categorised headings/columns for the arrangement of this document. Furthermore, the importance of colour and visual aid within this tool was also stressed, establishing it as a useful element to identify the different levels of risk. In addition, the technique of brainstorm sessions and risk workshops employed in the development stages of the risk register was also highlighted. As such it is clear that this objective has been achieved through the acquired findings.

The second objective of this study was to identify and examine how PMs actually use the risk register in their project risk management practice. As discussed earlier, the responsibility for producing the risk register was generally conceived as the duty of the PM. Moreover, it was also held that the Cost Consultant on occasion has responsibility for this production. Also, the frequency of the PMs' use of the risk register was addressed from the monthly reviews of this document by the PM and project team. In turn, this provides a realisation of Objective 2 of this research, broadening the understanding of how PMs use this tool in practice.

In relation to the third objective, the front end and feasibility stages of a construction project were identified as the crucial stages of a project where the risk register has its greatest influence. The risk register was generally conceived as a useful aid in the decision making process, thus influential during these initial project phases. Furthermore, it was noted that the scale and characteristics of the project risks change as the project progresses. In turn, this information fully realises this objective and develops the understanding of this document and its application as a project tool.

The results relating to the fourth objective reveal that the risk register should not be treated as a confidential document. Although, it was noted that some of its content

should be withheld from the public domain if it reveals potentially harmful information to the project. In addition, half of the interviewed PMs noted their incorporation of the risk register within the contractual documents, with a further two PMs detailing that certain aspects will be included. Therefore, the findings on this topic develop the understanding of the risk register's content and its integration into contractual documents, thus achieve the fourth objective of this study.

The significance of the risk register in the project management process was the main focus of the fifth objective. The results indicate the extensive use of the risk register as an effective tool within the project management methodology, with the majority of PMs deeming it as an essential component on any project. Moreover, the findings elicit how the risk register is the favoured tool for risk management, compared to other techniques such as a Monte Carlo simulation. As such, this accentuates the risk register's significance as a tool within the project management process, thus fully realising the final objective of this study.

RECOMMENDATIONS FOR FUTURE WORK

The majority of PMs were of the view that risk registers constitute an essential component of their project risk management practices. Hence, there is a need for further research on the extent to which risk registers actually help PMs to control the risks in a construction project, particularly residual risks, and how the use of risk registers can help to minimize deviations from expected outcomes. An area of future research could also expand on how the Cost Consultant produces and develops the risk register, with a focus on the register as a financial reporting document. Additionally, a further examination of the risk register forming as contractual documentation, with emphasis on the risk register having legislative influence would also be welcomed.

APPENDIX

Seven Tables are presented in this Appendix;

Table 1: Interview Questions

Table 2: Profile of Respondents

Table 3-7: Summary of Interview Results

INTERVIEW QUESTIONS

Table 1: Interview Questions:

01	What format of a risk register do you use? Objective 1
02	Do you think it is essential for a risk register to contain colour? Objective 1
03	How are risks identified and assessed for a risk register? Objective 1
04	What kinds of factors are fed into a risk register? Objective 1
05	Are the risks categorised? If so how? Objective 1
06	Who is responsible for producing the risk register? Objective 2
07	How is the impact of each risk calculated? Objective 2
08	How often is the risk register reviewed? Objective 2
09	Who decides who is responsible for each risk? Objective 2
10	Is there one person responsible for the actions taken to mitigate and manage each risk or are they controlled as a team? Objective 2
11	Is there ever more than one risk register to show an individual activity in more detail? Objective 2
12	Do different stages of a project pose different scales of risk? Objective 3
13	At what stage of a construction project do risk registers have the most influence? Objective 3
14	Are risk registers ever deemed as a confidential document of a project? Objective 4
15	Do risk registers ever form part of the contractual documents? Objective 4
16	How significant is a risk register in the overall project management approach? Objective 5
17	Are risk registers deemed as the best means of risk management compared to other techniques? Objective 5
18	Do you think it is essential for a risk register to be used on a project? Objective 5

PROFILE OF RESPONDENTS

Table 2: Profile of Respondents

Interviewee	Organisation	Job Title	Project & Construction Management Organisation	Project Management as Additional Service of Organisation	Large Scale Projects	Medium Scale Projects	Small Scale Projects
PM 1	Organisation A	Project Director		✓	✓	✓	
PM 2	Organisation A	Senior PM		✓	✓	✓	
PM 3	Organisation B	Senior PM		✓	✓		
PM 4	Organisation C	PM	✓			✓	✓
PM 5	Organisation D	PM	✓			✓	✓
PM 6	Organisation D	PM	✓			✓	✓
PM 7	Organisation E	Divisional Director		✓		✓	✓
PM 8	Organisation F	Managing Director		✓			✓
PM 9	Organisation G	Partner		✓	✓	✓	✓
PM 10	Organisation G	Partner		✓	✓	✓	✓

Notes:

Size of projects was determined from research into each organisation's catalogue of projects, primarily based upon financial capital and value.

SUMMARY OF INTERVIEW RESULTS

Table 3: Summary of Interview Results for Objective 1;

	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	PM 9	PM 10
Q1	Spreadsheet	Spreadsheet	Spreadsheet	Spreadsheet	Spreadsheet	Excel spreadsheet	Excel spreadsheet	Excel spreadsheet	Excel spreadsheet	Spreadsheet
Q2	Yes	Not essential but helpful	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Nice to have but, not always practical
Q3	Brainstorm Session	Risk Workshop	Brainstorm Session	Intuition/ experience	Brainstorm Session	Previous Experience & Risk Workshop	Risk Workshop	Brainstorm Session	Through discussion with Design Team	Brainstorm Session
Q4	Time, cladding, statutory undertaking	Time, quality & overall cost	Schedule/ Time	Procurement, Contract, Market, Inflation.	Planning, Environmental, Statutory, Undertakers, Timescales, Programmes	Ground conditions, Depends on job	Varies depending on project	Project funding, Programme, Weather	Everything that could go wrong and have an impact...very context specific	Project specific- everything from funding, planning & ground conditions
Q5	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Not usually...but would be easier to follow	Yes

Notes: PM – Project Manager; RR – Risk Register

Table 4: Summary of Interview Results for Objective 2;

	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	PM 9	PM 10
Q6	PM, sometimes Cost Consultant	PM	PM	PM	PM, sometimes Cost Consultant	PM	Cost Consultant	PM	PM with financial input from QS	PM or Lead Consultant
Q7	Probability x Impact	Likelihood x Impact	Probability x Severity	Probability x Impact	Probability x Impact	Probability x Impact	Probability x Magnitude	Severity x Impact	Impact x Likelihood	Probability x Impact
Q8	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly	Fortnightly/ Monthly	Monthly	3-6 months & at key gateways
Q9	Whoever best placed	PM	PM	PM	PM/ Cost Consultant	PM	PM	PM	Whoever best placed but ultimately PM	PM or Lead Designer
Q10	Team & One Owner	One Owner	Team & One Owner	Team, led by PM	One Owner	One owner & PM	One Owner	Team & One Owner	Team/one owner, PM has ultimate responsibility	Team & One Owner
Q11	Yes	No	Yes	No	No	No	No	No	No	Yes

Notes: PM – Project Manager; RR – Risk Register

Table 5: Summary of Interview Results for Objective 3;

	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	PM 9	PM 10
Q12	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes
Q13	Front End	One Phase to Another	Proposals	Feasibility	Front End	Feasibility	Front End	Front End	Front End	Front End

Notes: PM – Project Manager; RR – Risk Register

Table 6: Summary of Interview Results for Objective 4;

	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	PM 9	PM 10
Q14	No	No	Yes	No	No	Yes	No	No	Depends on risks	No
Q15	No	Possibly	Certain Aspects	Certain Aspects	Yes	Yes	Yes	Yes	Yes	Depends on project

Notes: PM – Project Manager; RR – Risk Register

Table 7: Summary of Interview Results for Objective 5;

	PM 1	PM 2	PM 3	PM 4	PM 5	PM 6	PM 7	PM 8	PM 9	PM 10
Q16	Essential	Significant	Significant	Significant	Significant	One of a number of tools	Very Good	Significant	One of a number of tools	Key part of approach
Q17	Project Dependent RR most used	RR best method	Monte Carlo used with RR	RR excellent tool	RR mainly used	Monte Carlo used more	RR most practical	RR only method used	RR only method used	RR best method
Q18	Small projects no, big projects yes	Yes	Yes	Yes	Yes	Yes	Good practice not essential	Yes	Depends on project, but generally yes	Not essential on small projects, but larger projects definitely

Notes: PM – Project Manager; RR – Risk Register

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