Construction Risk Identification

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Abstract

The management of risks in projects is a growing area of concern in the construction industry. Both the identification and analysis phases of the risk management process are considered the most important, for they can have a big impact on the accuracy of the risk assessment exercise. Currently it is assumed that construction project managers rely largely on experience to identify projects risks. These decisions, influenced by individual perception and attitudes, are made primarily under conditions of uncertainty. How individuals respond to risky or uncertain situations therefore requires an understanding of how individuals intuitively assess the situation they perceive, before expressing a response. The ProRIde project interviewed fifty-one construction project managers using Active Information Search (AIS) as a data collection method and cognitive mapping as a data-capturing tool. Our results suggest that the role of experience in the risk identification process is much less significant than is commonly assumed to be. By contrast, level of education and style of enquiry do play a significant role in risk identification performance. These findings suggest the potential for a more thorough approach to risk identification.

Keywords: project risk management, risk identification, active information search and cognitive mapping.

1. Introduction

Risk management has become an important area of interest in the field of construction project management over the past decade. Interest in the management of risk has increased as competition between firms, and as the size and complexity of project has grown. This has led to the development of best practice standards, tools and techniques. Both the risk identification and risk analysis phases of the risk management process (RMP) are generally considered the most important as these can have the biggest impact on the precision of the risk assessment [1-3]. While the analysis process and its tools and techniques are well developed, such analysis is dependent on risk being accurately identified in the first instance. However, compared with the analysis phase, the process of risk identification is poorly understood and the tools and techniques are less developed. The aim of the ProRIde research funded by the UK Engineering and Physical Sciences Research Council (award GR/N51452/01) is to provide a better understanding of the project risk identification process. Thus we focus our research on the ways in which construction project managers identify risks; our aim is to provide the basis for a more rigorous approach to the identification phase of project risk management.

2. Project Risk Management: An Overview

Interest in project risk management has increased as the size and complexity of projects has grown and as competition between businesses intensifies. The rapidly changing context and its influence on the way projects develop has made the RMP an ever more important challenge. Numerous best practice standards such as *A Guide to the Project Management Body of Knowledge* (PMBoK® Guide)[4], *Project Risk Analysis and Management Guide* (PRAM) [5], *RAMP: Risk Analysis and Management for Projects* guide [6] and the British Standards Institution guides [7; 8], as well as specialist tools and techniques have been developed focussing on a more effective RMP. These standards share a basic conception of the RMP (Figure 1). This generic model consists of four basic sub-processes located in the context of clearly defined project objectives, which are iteratively looped through the project lifecycle: identify and classify the risks, analyse the risks, respond to the risks and monitor the risks. There is also a growing body of research on the process as a whole, with increasing advocacy of risk management maturity models [9].

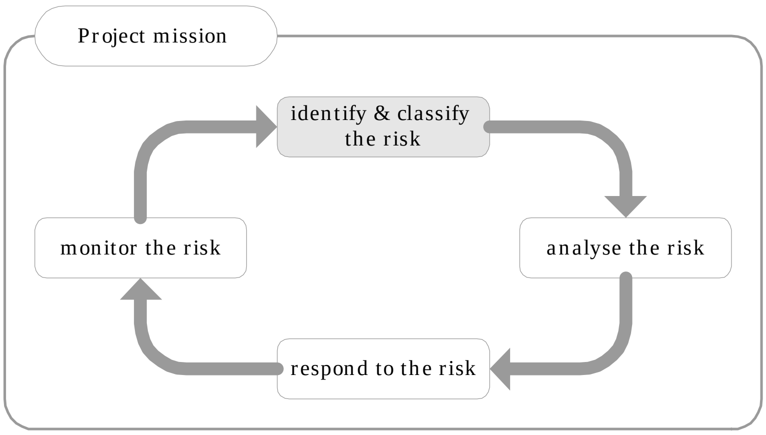

Figure 1: A generic model of the risk management sub-processes [10]

The identification phase, where the question of what might happen is addressed, has been the subject of much less research compared with the analysis phase. The most recent exceptions include research on the effectiveness of risk identification tools at group level [1] and the influences on risk identification and assessment in construction design management [11]. However, risk identification remains a poorly understood process and its tools and techniques are less developed compared to those used in the risk analysis phase [12; 13]. The focus of the literature is on the tools and techniques used for assisting in risk identification, such as risk registers, risk breakdown structures (RBS) and brainstorming. The widely used risk register is a list of all the risks that have been previously identified; its development is typically ad-hoc. For this to be of practical use, the register has to be filtered for a particular project under scrutiny and the results prioritised. However, it is not clear how this is done and how reliable the results are [14]. There appears to be a complete lack of connection with the literature on knowledge management as a tool for capturing organisational learning from projects [15]. Gaining such understanding requires the systematic analysis of data for a large number of projects, but such data sets are difficult to acquire – Dalton [16] reports on one attempt to fill this gap. RBS provide a hierarchical structure of potential risk sources [17] from which a list of risks can be drawn through a brainstorming session. Brainstorming [18] is project specific and requires a group of experienced practitioners to creatively consider possible risk sources. The list is then more analytically considered and key risks identified. The difficulties with brainstorming include the selection of the appropriate experts and their number, bringing these experts together frequently enough to be of use to a dynamic project lifecycle, and the avoidance of “groupthink” dynamics.

In construction projects there are some standard risk areas that need to be considered and assessed, but each new project also brings specific project related risks, which need to be identified. The difficulty is the lack of accurate systems for identifying risks in a construction project. The studies that have been carried out over the past decade on the use of risk management practices in construction and other industries [1; 2; 19-23] indicate that over this time: checklists, brainstorming and interview sessions have been the most commonly used risk identification tools; other techniques are rarely used due to lack of knowledge and doubts about their applicability in the construction industry; there is limited progress on the wider application of tools and techniques; there is concern that in practice the distinction between the risk management process phases is blurred and existing tools are not sufficient. Research currently assumes that the construction industry relies heavily on historical data and the judgement of key actors involved in the project to identify risks. For instance, Chapman [11], and Al-Tabtabai and Diekmann [24] state that the identification of risks relies on the individual judgement and insight of the various actors involved in a project, which is dependent on their knowledge, professional training, role, level of responsibility and length of exposure to the construction industry. The premise of both research and practice in project risk management is that experience is *the* key to risk identification.

3. ProRIde: the Method

Project risk identification is part of the more general problem of judgement under uncertainty [25]. To address this problem in a project context, we draw upon a critique of the predominant perspectives in this area –*Expected Utility Theory* [26]. Here the decision-maker rationally evaluates the probabilities against a final asset position before choosing a course of action. However, this theory has been criticised for its assumption that rationality is possible under such conditions, because evidence has been found that decision-makers use flawed heuristics in decision-making, which are subject to systematic biases [27; 28]. Within this perspective, Kahneman and Tversky [29] proposed their *prospect theory*, a system in which decision-makers assign values to gains and losses rather than to final assets and to decision weights rather than to probabilities. This produces the distinctive s-curve value function of the theory. While there have been important debates within the heuristics and biases literature [30], this probabilistic approach to decision-making has been widely accepted. However, the heuristic and biases critique of expected utility theory has been criticised on methodological grounds due to the artificial nature of the decision problems [31]. In essence, decision-makers are presented with well-defined problems with all required probability distributions available. In practice, an active information search is required by decision-makers to tease out the nature of the problem situation and assign the appropriate decision weights to the data. This naturalistic approach is much closer to the sort of situation facing project risk decision-makers than those of perfect information envisaged by expected utility theory and bounded rationality envisioned by prospect theory. The research methodology used in this research is based on active information search (AIS).

AIS was developed to study judgement and decision-making in naturalistic tasks. These are ill structured problems of information rich domains, where causal relations and attributions and the decision-makers' control belief are relevant [31]. At its core AIS is a process tracing technique of information search and collection, carried out in the context of an interview where the interviewee is presented with a scenario of a problem. After the review of the scenario the interviewee asks the facilitator questions in order to obtain information. These questions are recorded and answers are provided in printed form. Huber's model of how individuals reach a decision in a naturalistic situation assumes that the decision maker constructs a simple mental representation of the situation and alternatives, which can change in the course of the decision process. This research utilises the developments in these techniques proposed by Ranyard et al. [32] and Williamson and Ranyard [33; 34].

These developments do not, however fully address the issue of the recording of the cognitive processes revealed by the AIS technique. For this reason, we turned to cognitive mapping as a data recording and analysis method. Cognitive mapping [35] is an interactive decision support tool used to analyse the complex or messy processes through which decisions emerge. A cognitive map is a graphical model that structures the way and individual makes sense of their experiences. The map is represented by concepts (distinct phrases) and links between concepts, thus creating a system of concepts that communicate the nature of a problem. Although cognitive mapping has already been used in the project risk management area [36] [37], its application to the problem of project risk identification and its combination with an active information search methodology is novel.

The ProRIde AIS interview procedure [38] lasted between one and a half and two hours and was structured in three stages: 1) introduction and warm-up; 2) AIS/scenario exercise; 3) summary. The introduction informed the interviewee of the aim of the project, the structure of the interview process and what was expected of the interviewee. The aim was to clarify the exercise to the interviewee, but at the same time information was kept to a minimum so as not to influence the outcome of the AIS exercise. The warm-up exercise aimed to clarify the dynamics of the main exercise (AIS), such as thinking aloud and using questions and answers. The aim of the summary was to obtain a retrospective view of the risks identified.

The aim of the AIS exercise was to produce a response from the practicing managers that would match, as much as possible, their natural behaviour. The scenario, based on a real construction project, was developed by the research team in collaboration with the project manager of the real project. The scenario described a building project under a Design and Build contract that was currently in progress; participants were given limited information about its location, team, cost, client and project status with a focus on schedule and budget risks. The limited information meant that the potential of the scenario to shape the interviewees' responses was kept to a minimum and would compel the interviewee to request additional information from the facilitator. This process needed to occur in order for the AIS method to work. Each interviewee was asked to assume that they were part of the project team and that they had to take over the project at short notice. Each interviewee then went through the AIS process described above with the aim of identifying the main risks in the project.

4. ProRIde : Initial data analysis

Potential interviewees were initially identified by our four collaborating UK construction firms. These firms comprised: two large international construction firms, one large UK national construction firm, and one medium-sized London-based construction firm. The criteria for the selection of interviewees included individuals with a minimum of two years experience in a construction management position and who could potentially take over a project at short notice. As the interviews progressed, the four firms provided our research team with a list of twelve-to-twenty potential participants. To select the interviewees, our research team used a judgment sampling based on professional role. We interviewed fifty-one (4 female, 47 male) practicing construction project managers from the four collaborating firms. The first five interviews constituted a face validity exercise for both the risk propensity questionnaire and AIS approach. Two interviews could not be conducted properly due to time constraints; we have excluded this data from the analysis. We used for this analysis the data from 45 of our interviews. Although our sample is not random, we believe that it is reasonable to suggest that our findings offer fairly typical results for middle-level managers in the UK construction industry. We have no reason to believe that it is systematically biased in any particular way; we believe that the results can be generalized to other project managers on asset acquisition projects.

4.1 Active Information Search Analysis

Both the scenario and summary stages were tape-recorded; from this, transcripts were generated. The verbal reports (sequential transcripts) contain data on the lines of reasoning and type of information searched for and used during the scenario exercise. Due to the volume of data gathered (15-20 pages per transcript) we recognized that we needed to do more than analyse the content. Therefore, we used Decision Explorer™ (cognitive mapping software) to graphically represent the AIS data. This type of graphical representation can still be considered a cognitive map because it represents "*people in relation to their information environment*" [39]. For the purpose of clarity, we will refer to these as *information search maps.*

Our maps were built by transcribing the information directly into Decision Explorer™ . Starting at the beginning of the tape, we entered sequentially numbered concepts (distinct phrases) into Decision Explorer and linked these to represent a chronological relation (concepts following in time). A concept could be a question or statement from the interviewee or an answer from the facilitator. The sequence of concepts and links was broken when a new question was asked about a new or different theme; the new concept then marked the start of a new line of inquiry and reasoning. During this stage, we developed a coding framework for three distinct variables: concept variable, process variable and outcome variable. The concept variable was coded as answers (facilitator's input), questions and statements. The process variable indicates the approach taken to search and collect information; this could be in a *linear* or *feedback* mode. A linear style approach was evident when the interviewees asked a series of single independent questions without follow-up. A feedback-style approach was evident when the interviewees asked a series of related questions in an investigative manner. The outcome variable is the risks identified by the interviewees. To improve coding reliability, two coders independently examined the information search maps. The comparison between coded maps indicated a high percentage of agreement (.99) between the two coders.

Each coded map contained between 200 and 600 concepts. To help manage the data, we used the Decision Explorer™ cluster analysis option, in which individual information search maps were segmented into groups of concepts (called clusters). Concepts were grouped based on the strength of linkage. Each cluster describes the sequence and style of information search an interviewee went through during a particular theme of the scenario. In this sense, each cluster describes a specific theme; and each is given a title to capture its contents.

In order for the *information search maps* to be compared, it was necessary to summarise them further. Therefore, a *summary information search map* was created for each interviewee using VISIO™. These summary maps contain data about the information that was sought (cluster titles), the sequence of the information search (arrows), the number of questions asked per theme (cluster size and number in parenthesis), the style of information search used (feedback, linear), the approaches used (assessment, self orientation, further action), the risks identified, and feedback loops (dashed links). Figure 2 provides an example of an individual summary information search map.

To read the summary information search map start at the bottom left side and work your way through by following the arrows. We can see that this interviewee searched for information related to the schedule and sectional handover in the first instance (cluster 1). This information was sought using a feedback style approach (arrowed circles), where 3 questions were asked (number in parenthesis). A feedback style was the main style of information search used (more than 50% of clusters are feedback); this led to the identification of three risks (coded as b,c,d). A linear style approach was used to cover permit aspects and one risk (coded as a) was identified through this approach. By reading the cluster titles we can see that the scope of information search was limited to very particular aspects of the project, such as things on the ground and design. Self-orientation was a common strategy used to navigate through the information acquired during the task (clusters 7,15,16,17,18,19,21). In total four risks were identified with limited scope and impact.

The project manager who managed the real-life construction project on which the scenario was based is a member of the research team. We were able, therefore, to benefit from his detailed knowledge of the scenario's background to assess the potential impact that each of the risks identified by the interviewees would have on the scenario project. In other words, we benefited from hindsight knowledge in establishing the potential impact of each risk event identified by the interviewees. This procedure allowed a risk identification performance (RIP) measure to be developed. All identified risks were entered into a matrix and rated individually on a 1 (very low) to 5 (very high) impact scale. The rated matrix was independently reviewed for consistency. The total number of risks identified by each interviewee weighted by their potential impact gave us the RIP measure for each interviewee. It is important to note that the RIP measure is not an indication of absolute level of performance, but a relative measure, constrained by our choice of scenario. Due to the use of hindsight, it was not believed to be appropriate to allocate a probability of each risk event occurring to complement the impact. The RIP forms our dependent variable in the subsequent quantitative analysis of the information search maps.

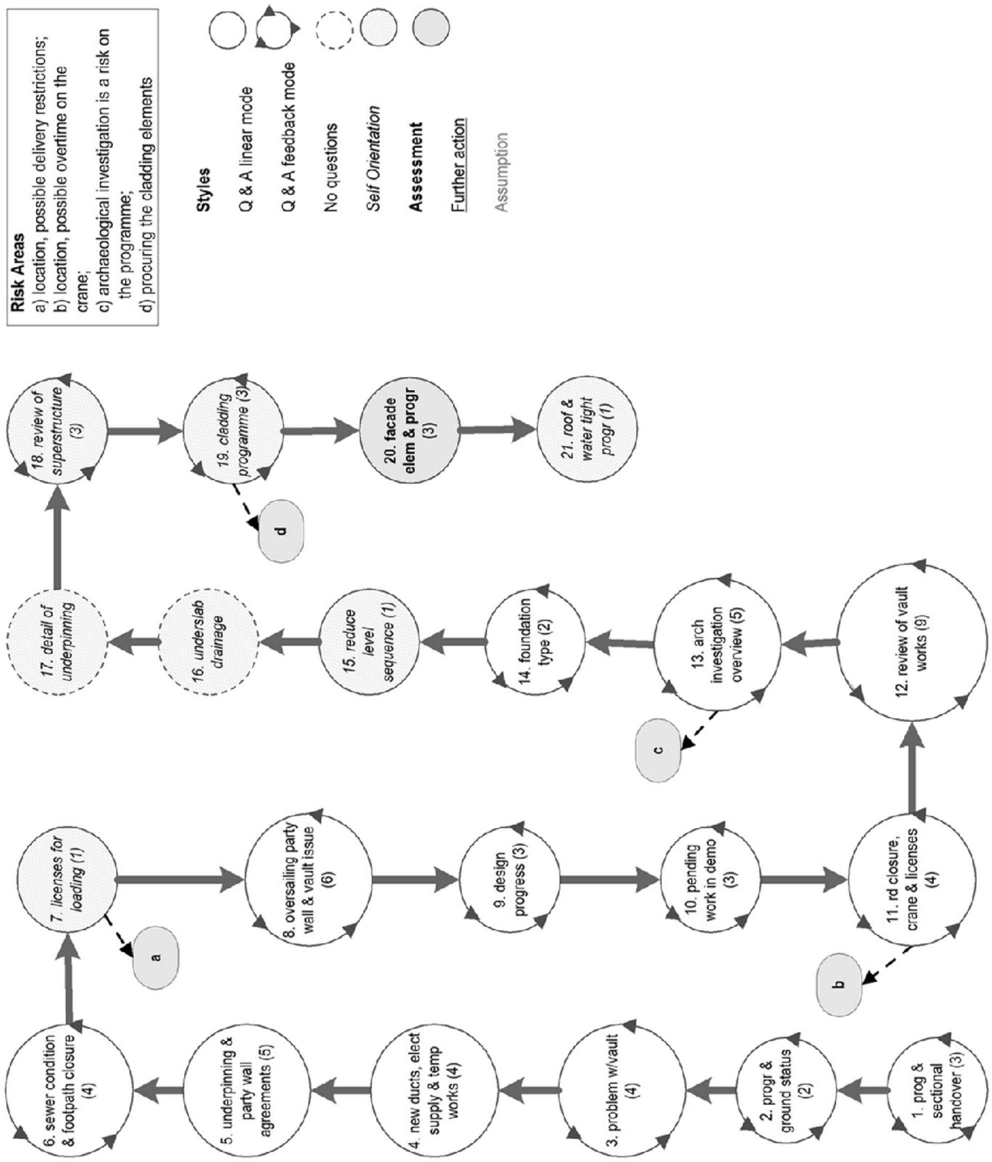

Figure 2: Summary Information Search Map : Feedback style

5. Quantitative results

The individual summary maps provide an overview of the individual risk identification process. These provide data on the information that was sought, the sequence of the information search, and the strategy used for the information search; these also detail which decisions were based on prior experience or training and which were based on information collected during the exercise.

When combined with the results from the risk propensity questionnaire, these provide the data set for the first phase of our research. In this analysis, simple frequency counts and statistical tests are used to explore the patterns in the data set. This quantitative analysis will be complemented by a qualitative analysis of the maps at a later date.

*Table 1: RIP and Demographic Factors (n = 45 * significant at 5% level in all tables)*

Independent Variable	***t- test***	***Spearman's Rho***	***Pearson r, Point-biserial r_{pb} Biserial r_b***
Years in management role			r = -.186
Years in current job title			r = -.198
Age			r = -.160
Risk management training	t = 1.157	ρ = -.212	r_{pb} = -.174
Role	t= -.819		$r_{b\,=}$ .166
Education	t = -2.211 *	ρ = .291 *	r_{pb} = .320 *

The risk propensity questionnaire contained a number of standard demographic variables measuring age, experience, education background and level of risk management training which allow us to test these assertions. In our analysis, we treated RIP as the dependent variable and the demographic factors seriatim as the independent variable with a null hypothesis that there is no association between the two. Our review of the data determined the choice of statistical test; the results are summarised in Table 1. As can be seen, we cannot reject the null hypothesis at the 5% level except for the education coded as whether the interviewee was a graduate or not. Experience measured by years in current job title, years in a management role, and age are not significantly associated. Similarly, whether the interviewee has had risk management training or whether his or her role is commercial or production orientated displays no significant association with risk identification performance.

We then took the RIP measure as the dependent variable and style of information search (feedback or linear) as the independent variable with a null hypothesis that there is no association between the two. The results are summarised in table 2. As can be seen we can reject the hypothesis at 5% level for style ratio (ratio of linear/feedback clusters), linear clusters (negatively associated) and feedback cluster (positively associated). This suggests that, as more feedback style of information search was used the higher the RIP score obtained and the inverse for a linear style.

Having identified information search style as significant, we took information search style (feedback and linear) as the dependent variable and experience as the independent variable with a null hypothesis that there is no association. The results are summarised in tables 3 and 4. As can be seen, we cannot reject the null hypothesis at 5% level. This suggests that feedback and linear styles of information search are not significantly associated with experience, measured in number of years in a management role, years in current job title and age.

Next, we took the styles of information search (feedback and linear) and style ratio as the dependent variable and educational attainment (graduate and non-graduate) as the independent variable with a null hypothesis that there is no association. As can be seen in table 5, we cannot reject the null hypothesis at 5% level except for style ratio correlated with educational attainment. Box plots show that style ratio and education were related with more non-graduates tending to have a higher style ratio (more linear style). This suggests that higher educational attainment encourages the use of a feedback style of enquiry in risk identification.

Table 2: RIP and Process Variable

Independent Variable	***Pearson r***
Style ratio	r = -.313 *
Linear clusters	r = -.274 *
Feedback clusters	r = .310 *

Table 3: Feedback style and experience

Independent Variable	***Spearman's Rho***	***Pearson r***
Years in management role	ρ = -.042	r = -.049
Years in job title	ρ = .032	r = -.002
Age	ρ = -.040	r = -.027

Table 4: Linear style and experience

Independent Variable	***Spearman's Rho***	***Pearson r***
Years in management role	ρ = -.241	r = -.232
Years in job title	ρ = -.099	r = -.076
Age	ρ = -.099	r = -.114

Table 5: Information search styles and education

Dependent Variable	***Point-biserial correlation***	***t-test***
Style ratio	r_{pb} = -.268 *	t = 1.1794 *
Feedback cluster	r_{pb} = .052	t = -.344
Linear cluster	r_{pb} = -.117	t = .775

From these data, therefore, we can conclude that there is a significant difference in project RIP between those educated at graduate and non-graduate level; and an association between the style of information search (feedback and linear) and RIP. This finding is both counter-intuitive and interesting. It is counter-intuitive, because it suggests that experience plays no role in project risk identification performance. It is interesting because it suggests that education and training can improve project risk identification performance - years of experience is not subject to managerial intervention to improve performance, but it is possible to train staff. However, the lack of correlation with whether the interviewee had experienced risk management training suggests that existing training programs are not all that they might be. In addition, we find that the process style in which information is gathered also contributes to the RIP. In this case, a feedback style, that is, an iterative investigative approach to information gathering contributes to a better RIP. Again, this suggests the potential for staff training.

6. Conclusions

This paper describes a method for studying how project managers in the construction sector go about identifying risks. The review of the risk management literature showed that the risk identification phase of the risk management process, although one of the most important is poorly understood and that the tools and techniques available are less developed than the ones used in the analysis phase. The review also highlighted the construction industry's concerns about the lack of formal methods to identify risks, as well as their lack of knowledge and doubts about the suitability of the ones available. Understanding how project managers identify risks, that is, the means by which they use their knowledge, expertise, and training, places the inquiry in the area of judgement under uncertainty. The review of the development and critiques of key decision-making theories pointed towards the importance of the use of active information search for teasing out the nature of a problem situation. As a result, the methodology used to study the risk identification process is a conversation-based Active Information Search in combination with cognitive mapping.

Both feedback style and educational background have been highlighted as significant. In sum, the results show that interviewees with a high use of feedback style of information search performed better at identifying high impact risks. Or to put the point the other way round – experience appears to contribute little to effective project risk identification. More detailed analysis of the results suggests that more experienced project managers are more likely to rely upon what might be described as a "checklist mentality", rather than addressing themselves to the details of the particular project they are being asked to manage.

This paper has provided some insights and better understanding into the way that construction project managers identify risk. The method has allowed us to capture the initial thoughts and process. The findings suggest that the preconceptions about the importance of experience of actors in the initial phase of risk identification may well be misguided. We are presently building on these results to do a more qualitative analysis of the ways in which individuals identify project risks, and are also starting to explore the group dynamics of project risk identification.

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