A Review of Project Risk Management

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Abstract: Since project risk management is of particular importance in the execution of all projects, special attention should be given to large scale projects as they have many areas of risk through the whole project life cycle. During the preliminary phase of the project life cycle, important strategic decisions are taken thus a professional risk management is needed in this phase to improve the identification and implementation of suitable response actions. This review paper contains a review of recent research relating to project risk management. It presents an overview of the basic concepts in risk management by conducting its different processes, projects lessons learned, and projects debriefing methods. It considers project risk management using the technique of risk breakdown structure. Related areas of risk management in large projects are called upon in this paper so this paper can act as a source document for further study. The risk cube technique and questionnaire survey technique which are two of the simplest and effective techniques in the risk load of the various project elements are discussed within this paper .Finally the risk elements associated with executing large scale projects influence the time; cost, technical achievement, and quality are discussed and concluded.

Keywords: Project risk management -Project life cycle - Risk processes - Basic concepts - Project preliminary Phase - Projects Lessons learned – Projects debriefing methods – Risk Breakdown Structure – RBS- project risk cube – questionnaire Survey - time - cost - technical achievement – quality

1. Introduction

In the management of large scale projects, the question of project risk management is of Particular importance. Consideration of risk management aspects leads to more effective project management during the project life cycle (1). Furthermore, Project risk management includes the processes concerned with conducting risk management planning, identification, analysis, responses, and control on a project; most of these processes are updated throughout the project (2).

In a project life cycle, the preliminary phase is particularly critical as it is the time when important strategic decisions are taken without the help of detailed information on time and cost. The risk analysis of the preliminary phase of the project seeks to identify the sources of uncertainty and to develop response actions to limit the risks (3).

Risk management includes project uncertain, favorable events. Moreover risk management represents an integral part of project management throughout the entire project life cycle. In fact, it is important that risk exposure and response actions are monitored continuously (4).The objectives of project risk management are to increase the probability and impact of positive events, and decrease the probability and impact of events adverse to the project (2). The risk cube technique and questionnaire survey technique which are two of the simplest and effective techniques used in the risk load of the various project elements (25, 26, 27, and 37).

The systematic retention of project experiences enables project managers to compare their various Projects more systematically and solve effectively their problems. Systematic project lessons learned enhances project managers to overcome and avoid many problems. Project debriefing methods process can be integrated successfully into project procedures. Project lessons learned and debriefing methods are used successfully in project risk management (5).

Time, cost, technical, and quality achievements on large scale projects are uncertain (6) because of technological constraints, long duration, large capital requirements, and improper scope definitions. Large scale projects are exposed to uncertainties (7). Since project risk management is of particular importance in the execution of all projects, special attention should be given to large scale projects as they have many areas of risk through the whole project life cycle.

2. Recent Research Relating to Risk Management

- Porter (8), Healy (9), and Perry and Hayes (10) have expressed risk as an exposure to economic loss or gain arising from involvement in the construction process.

- Mason (11) and Movenzadeh (12) have regarded risk as an exposure to loss only.
- Bufaied describes risk in relation to construction as a variable in the process of a construction project whose variation results in uncertainty as to the final cost, duration, and quality of the project (13).
- It's generally recognized that those within the construction industry are continually faced with a variety of situation involving many unknown, unexpected, frequently undesirable and often unpredictable factors (14).
- Ashley (15) and kangari and Riggs (16) have all agreed that these situations are not limited to the construction industry: it is recognized that risk is built into any commercial organization‘s profit structure and is a basic feature of a free enterprise system.
- Turner et al. (16), Knoepfel (17), Ireland and Shirely (18) have all agreed that projects have to be managed to achieve their objectives and it is important that these objectives be defined and specified.
- Steiner (19) has agreed that projects generally involve large, expensive, unique, or high risk undertakings which have to be completed by a certain data for a certain amount of money, within some expected level of performance.
- C.B.Champion and D.F. Cooper (20) defined risk as exposure to the possibility of economic or financial loss or gain, physical damage, or injury, or delay as a consequence of the uncertainty associated with pursuing a course of action.
- Williams (21), Baker (22), Cooper (23), and Dey (24) have all shown that risk management is used effectively as a tool for managing projects effectively throughout its life cycle.

3. Basic concepts in risk management (2)

Project Risk Management includes the process concerned with conducting risk management planning, identification, analysis, responses, and monitoring and control on a project; most of these processes are updated throughout the project. The objectives of project risk management are to increase the probability and impact of positive events, and decrease the probability and impacts of events adverse to the project.

Risk management Planning means deciding how to approach, plan, and execute the risk management activities for a project.

Risk Identification means determining which risks might affect the project and documenting their characteristics.

Qualitative Risk Analysis means prioritizing risks for subsequent further analysis or action by assessing and combining their probability of occurrence and impact.

Quantitative Risk Analysis means numerically analyzing the effect on overall project objectives of identified risks.

Risk Response Planning means developing options and actions to enhance opportunities, and to reduce threats to project objectives.

Risk Monitoring and Control means tracking identified risks, monitoring residual risks , identifying new risks , executing risk response plans, and evaluating their effectiveness throughout the project life cycle.

These processes interact with each others and with the processes in the other knowledge areas as well. Each process can involve effort from one or more persons or groups of persons based on the needs of the project. Each process occurs at least once in every project and occurs in one or more project phases, if the project is divided into phases. Although the processes are discrete elements with well defined interfaces, in practice they may overlap and interact.

Risk analysis and management can only be as good as the perception and quantification of risk by the project team, and it is at this point that the credibility of risk analysis often falls down (7).

Project risk (24, 25) involves various parameters which depend on time. The associated risk exposure during the project life cycle may evolve as certain events occur. Both the risk response planning and the risk monitoring and control phases are very sensitive to the time dynamics of the risk. The principal time parameters that can be used to describe a risk are the risk time window, i.e. the period of time in which a risk may occur, which implies that the occurrence of the risk is not attributed to a given instant of time but to a period, and the impact time window, i.e. the period in

which the effects of a given risk may be felt. The time dynamics of the individual risk is considered, in order to render the identification and planning of response actions more effective and systematic. The aim of a dynamic analysis of a single risk is to add a further criterion in the choice of the major risks and so to avoid overlooking those risks that, with time and the occurrence of other events, may increase the overall project risk. Subsequently, the progress over time of the global risk to which the project is exposed in the course of its life cycle, identifying the periods of time with a greater risk load and requiring greater management attention. In addition to the time parameters described, the dynamic analysis of individual risks will also involve the use of the following concepts:

Risk chain means sequence of events which start from a source of uncertainty and pass Through a series of intermediate events (trigger events) before the final event of the Chain, the risk event itself, occurs (7).

State of the source means the risk source is an element of the project or its context but a risk chain is usually only activated if the source is in a certain state(7).

Trigger event means an intermediate event which may or may not occur during the risk Chain and may lead to the occurrence of a risk. Unlike a risk, a trigger event may not have any direct effect on project objectives (7).

Event tree can be employed both during the preliminary analysis and the project monitoring phases. The event tree shows all the possible paths which a sequence of events could follow and so lead to a risk, i.e. the final event of the chain. The tool describes the links between the Various trigger events and, if such an event occurs during the project, it can check how the Probability and impact magnitude of the related risk changes. (34)

4. Risk Management during the Preliminary Phase of Project Life Cycle

In a project life cycle, the preliminary phase is particularly critical as it is the time when important strategic decisions are taken without the help of detailed information on times and costs. The risk analysis of this preliminary phase seeks to identify the sources of uncertainty and to develop response actions to limit the risks (5).

In fact, it is important that risk exposure and the effectiveness of planned response actions are monitored continuously. If risks are not promptly addressed during the preliminary phase of the project, they can have a significant impact on project outcome (25).

In the preliminary phase of a project, risk analysis is concerned, above all, with major risks which can considerably modify project development. Only negative risks of unfavorable events are considered (2, 5). From my experience in the execution of several successful projects, the preliminary phase of a project should be studied and professionally risk managed because success in managing the preliminary phase of project is not that easy, thus it may be needed to determine changes to project objectives in this phase to be absorbed in the next phases of project.

5. Projects lessons learned, Projects Debriefing Methods, and RBS Technique

Successful and effective risk management requires a clear understanding of the risks faced by the project. This involves more than simply listing identified risks and characterizing them by their probabilities of occurrence and impact on objectives. The large amount of risk data produced during the risk process must be structured to aid its comprehension and interpretation, and to allow it to be used as a basis for action. A common language and terminology in project risk management are project reporting and lessons learned. One of the most difficult tasks in the project review is to structure the information so that it can be referenced and used by future projects (35).

Many organizations lose the benefits of such reviews, since the information is not held in an accessible format. The risk breakdown structure- RBS - can provide a common format for analyzing risk related information from each post project review. A risk breakdown based analysis will reveal risks which occur frequently, allowing generic risks to be identified and recorded for future reference, together with effective responses. If routine analysis of post project reviews indicates that a particular risk is occurring repeatedly, then preventative responses can be developed and implemented. Risk identification checklists can also be updated and maintained to include common or generic risks exposed by a RBS based analysis of post project review data (36).

Experiences gathered in different projects are not being systematically integrated into the organizational knowledge base and that there is a great discrepancy between the need for project debriefing and its actual deployment. In order to overcome this apparent gap, Martin Shindler, and Martin J. Eppler examined reasons for project amnesia and presented an overview on the available methods for the project centered gathering and use of lessons learned. As a result of this survey, the article presented various key success factors for effective debriefing methods (35).

The systematic retention of project experiences enables a company to compare its various projects more systematically and document its most effective problem solving mechanisms. In addition, the systematic documentations of mishaps, mistakes or potential pitfalls help to reduce project risks. From a long term perspective, systematic project learning enables the enterprise to develop project competencies that lead to a sustainable competitive advantage (35).

Experiences which are by definition bound to the people who are personally involved in the corresponding problem solving processes are often not a part of a project's documentation and they are seldom transferred to other people during the course of a project. Project team members return to their line functions (or they are being moved into other functions) after having completed their tasks in the project and they usually take their new experiences with them (28).

These experiences are then only accessible through informal networks. Relevant project documentation such as a feasibility study, a summary, a technical report or a user manual which has to be produced to meet minimal documentation standards is often superficial and has its focus on merely capturing standardized description of the project's results. Recordings of failure reasons or how particularly efficient solutions have been built or how certain special issues have been addressed are often omitted. The end of a project is consequently the end of collective learning. The involved staff moves on to new projects or they are reintegrated into their line functions. If their specific knowledge of that project is not directly needed, organizational amnesia begins (35).

In addition, external partners or consultants, who have provided crucial project inputs, leave the company after the completion of a project. In case their knowledge is needed (e.g. if similar problems occur in other projects) it is even harder to identify and can only be reconstructed partly without their personal support. Some consulting companies have realized this problem and emphasized the thorough documentation of their project work. Up until now, however, clients have often been reluctant to pay extra fees for this documentation effort. The risk of a knowledge loss at a project's end is a serious problem for organizations (33, 35).

From my point of view, the systematic retention of project experience records, most effective problem solving mechanisms, systematic documentation, relevant project documentation such as a feasibility study, project summary, technical reports, user manuals recordings of failure, efficient solutions of currently executed projects are all indicators of successful organizations .The successful close out of any project should be accompanied with lessons learned from that project , and it is an indicator of qualified project manager. Successful Contractors have projects data base which contain most of these records for previous and current projects. The use of data base enhances the application of risk management throughout the project life cycle.

6. Time, cost, technical, and quality achievements on large scale projects

The success parameter for any project is in time completion, within a specific budget and conforming to technical performance requirement. The main barriers in achieving these are changes that occur in the project environment. The problem multiplies with the size of the project as uncertainties in project outcome increase with size. Large scale projects are exposed to uncertain environments because of the following factors: (24)

- Planning and design complexity.
- Presence of various interest groups (project owner , owner's project group , consultants , contractors , vendors etc) :
- Resources (materials , equipment , funds , etc)
- Availability ;
- Climactic environment ;
- The economic and political environment
- Statutory regulations.

Although risk and uncertainty affect all projects, size can be a major cause of risk. Other risk factors include the complexity of the project, the speed of its construction, its location, and its degree of unfamiliar. Other conditions can include the influence of external factors that are beyond human control. External causes can limit resource availability, including the areas of techniques and technology. Various environment impact, government laws and regulations, changes in the economic and political environment, cost and time over-runs and the unsatisfactory quality of a project are the general sources of management disappointment. The three-fold criteria of success-meeting cost, schedule and performance targets have become widely used as they catch the essential task of the project manager. (9)

Insofar risk analysis and management is important to complete efficiently the activities of the large scale projects. By revising several techniques and methodologies which were carried out by several researchers for the qualitative and quantitative assessment of risk, I found that one of the simplest and effective techniques is using the risk cube (25). It estimates the risk load of the various project elements .In particular, the qualitative risk assessment provides an initial risk assessment by assigning qualitative values to the impact magnitude of the probability of occurrence of each identified risk. The outcome of this procedure is generally a matrix which identifies a certain number of discriminating zones, and therefore, the major risks are derived by calculating the impact on the four fundamental aspects: cost, time, quality, and technical performance thus taking the highest value of the four effects. The result is inserted into a five- level matrix (very low , low , medium , high , very high) with three discriminating zones , where the zone with the highest impact magnitude and probability of occurrence identifies the risks which require greater management attention(1, 3, 25, 28) . The qualitative analysis can be extended further by using appropriate numerical scales, so transforming the matrix from an ordinal to a cardinal representation. For each risk, a summary indicator of exposure can be calculated and the risks prioritized. With the risk priorities, possible response actions can be identified and collected together in the risk response plan (24, 25).By applying these concepts of risk management, they enhance risk monitoring during the project life cycle and enable a more systematic approach to the identification of possible response actions. Furthermore, the impact on the project is taken to be additive, so that if more than one risk influences the same activity, the overall risk exposure is taken as the sum of the individual exposures (24). From practical point of view, this allows to assess the risk load of single project elements, and realize sources of uncertainty from which risks derive. In this way, it is possible to identify the most critical aspects of the project which will require greater attention during project execution, and then effective project risk management can be applied.

Particular emphasis should be placed on the project stakeholders who are the most important sources of risk and opportunity in the preliminary phase of a project so as to improve the sharing of objectives through a communication plan which takes account of the characteristics of the individual stakeholders in terms of behavior, knowledge and level of influence. This proposed risk analysis methodology identifies the risk load on each stakeholder to ensure that it corresponds with the stakeholder's means to control the risk itself or to adopt appropriate contractual provisions (24, 25).

The risk cube technique (25)

The main aspects tied to risk can be represented by three coordinates which, in turn, are obtained from three typical project analysis tools;

- Activities described by the work breakdown structure (WBS)
- Risk owners described by the organization breakdown structure (OBS)
- Sources of uncertainty described by the risk breakdown structure (RBS).

The WBS contains all the planned project activities, including the feasibility study, the tendering process preparation, project management and the maintenance of the completed works. The OBS shows details of all the stakeholders involved in the project. The RBS gives a breakdown of the sources of risk in the project. By cross referencing these three structures, we obtain a three dimensional figure shows the critical elements of the risk which is called a risk cube. By using this technichue; the risk owners, activities and sources of a given major risk can be quickly identified.

With the risk cube framework, the value of risk exposure for each major risk and for each cube element e.g. . A project activity can be represented with increasing complexity by:

- Qualitative values (e.g. low , medium , high)

- Expected values (e.g. expressed in monetary terms)
- Discrete or continuous probability distributions.

It should be noted that it is possible to take into account possible dependencies between risks both in a qualitative and in a quantitative way. The risk cube represents a powerful tool in identifying possible correlations between risks, since correlation normally derives from a common uncertainty source. The risk cube is easy to use in the risk analysis and management process which has been formalized.

The Questionnaire Survey Technique (26, 27, 37)

By revising techniques, and methodologies of risk management from my literature review, I found another useful tool which was used widely by different researchers. This technique is questionnaire survey. They used this technique in the project risk analysis and management. It depends on the classification of respondents who should be professional and successful of project management. The samples used for survey by different researchers had not a fixed number of members. It varied according to the nature, complexity, and scope of work of assigned projects. Some examples of researchers who carried out this technique are given below:

Smiister (26) investigated the usage and benefit of project risk analysis and management in 1992, based on a questionnaire survey of 37 members of the UK association of Project Managers. Simister's survey was comprised of respondents classified into five works – related groups: defense industry (36%), management consultancy (36%), systems – based information technology (12%), telecommunications (12%) and engineering contracting (4%).

Macleod (27) investigated the usage and benefit of project risk analysis and management in construction projects relevant to all professionals and groups (client groups , design team , project management team , contractors , etc.) in the construction industry which are concerned with cost , time and quality . This research concentrated on two categories of respondents: contractors and project management practices. the sample for the survey was a total of 100 top firms in the UK construction industry comprising 70 general contractors and 30 project management practice .The general contractors were selected randomly from a list of 100 contractors published in the contractor file 1992 .The 30 project management practices were those advertising in building during the period June 1994 to August 1994. Subject to limitation of the sampling, the firms surveyed represent a large proportion of the UK construction industry population. The total turnover of the firms surveyed (£7000 million) represents 20% of UK contractors 'output for 1994 and had 50,000 employees. All the project management organizations are bona fide practices providing a wide range of project management services. The overall response of the survey comprised of 30 general contractors (CTR) and 13 project management practices (PM) representing a 43% response rate resulted from an initial mailing addressed to the managing director of each firm and a reminder letter , after two weeks , to those organizations that had not responded to the original request . The response rate is typical of a construction industry questionnaire survey and cannot be regarded as biased considering Moser and kalton 's assertion (37) that the results of a postal survey could be considered as biased and of little value if the return rate was lower than 30-40 % .

The questionnaires were completed by top management in the organizations (mainly directors and partners) and almost all of them (more than 90%) had over 10 years of professional and academic qualifications. On the basis of position, work experience and educational professional background, it can be inferred that the respondents have adequate knowledge of the activities associated with construction and associated risk.

7. Discussion and Conclusion

Since project risk management is of particular importance in the execution of all projects, special attention should be given to large scale projects as they have many areas of risk through the whole project life cycle. Risk management includes project uncertain, favorable events. Moreover risk

management represents an integral part of project management throughout the entire project life cycle. The preliminary phase of a project should be studied and professionally risk managed because success in managing the preliminary phase of project is not that easy, thus it may be needed to determine changes to project objectives in this phase to be absorbed in the following phases of project. The technique of risk breakdown structure is a powerful aid that provides a common format for analyzing risk related information from each post project review. A risk breakdown based analysis reveal risks which occur frequently, allowing generic risks to be identified and recorded for future reference, together with effective responses. The systematic retention of project experiences enables project managers to compare their various Projects more systematically and solve effectively their problems. Systematic project lessons learned enhances project managers to overcome and avoid many problems. Project debriefing methods process can be integrated successfully into project procedures. Project lessons learned and debriefing methods are used successfully in project risk management. The successful close out of any project should be accompanied with lessons learned from that project, and it is an indicator of qualified project manager. Successful Contractors have projects data base which contain most of these records for previous and current projects. The use of data base enhances the application of risk management throughout the project life cycle.

Risk elements associated with large scale projects influence the time, cost, quality, and technical performance of the project. The risk cube technique and the questionnaire survey technique are two of the simplest and effective techniques in the risk load of the various project elements. The success parameter for any project is in time completion, within a specific budget and conforming to technical performance requirement.

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