

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The construction industry has changed rapidly over the past 10 years; companies are faced with more risk and uncertainty than over before. Risk management has become an important part of the management process for any project. Risk in construction has been the object of attention because of time and cost overruns associated with construction projects. This chapter reviews the literature concerning some of risks faced in the construction industry, some of analysis techniques and risk response practices.

2.2 Defining Risk And Uncertainty

Risk can be defined as an uncertain event or condition that, if it occurs, has a positive or a negative effect on a project objective. A risk has a cause and, if it occurs, a consequence (Office of project management process improvement, 2003). Jaffari (2001) defined risk as the exposure to loss/gain, or the probability of occurrence of loss/gain multiplied by its respective magnitude. Events are said to be certain if the probability of their occurrence is 100% or totally uncertain if the probability of occurrence is 0%. In between these extremes the uncertainty varies quite widely. The Project Management Institute (1996) introduced a simple definition for risk as a discrete occurrence that may affect the project for better or worse. In order to emphasize the major objectives of survey on risk management actions, risk has been defined as the probability of occurrence of some uncertain, unpredictable and even undesirable events that would change the prospects for the profitability on a given investment (Kartam, 2001). Chicken and Posner (cited in Greene, 2001) provide their interpretation of what a risk constituents:

$$\text{Risk} = \text{Hazard} \times \text{Exposure}$$

They defined hazard as “ *the way in which a thing or a situation can cause harm*” , and exposure as “ *the extent to which the likely recipient of the harm can be influenced by the hazard*” . Harm is taken to imply injury, damage, loss of performance and finance, whilst exposure imbues the notions of frequency and probability. Risk is the triple characteristic of

any project decision in the situation of uncertainty. It can be defined as a trinity of risk event (A), risk probability (P) and function of risk losses (u):

$$R = (A, P, u)$$

The risk event (A) is a random event which is connected with any project decision (Titarenko, 1997).

Uncertainty is a situation in which a number of possibilities exist and which of them has occurred, or will occur, is unknown. Considering all risks are uncertain but not all uncertainty is risky (Yoe, 2000).

Risks and uncertainties characterize all activities in production, services and exchange. They affect all the fundamental variables that determine planning, implementation, monitoring, adjustment, behavior and explain choices, and bring about decisions (Okema, 2001). Any definition of risk is likely to carry an element of subjectivity, depending upon the nature of the risk and to what is applied.

Certainty exists only when one can specify exactly what will happen during the period that covered by the decision. This is not very common in the construction industry (Flanagan & Norman, 1993). Other writers see no difference between risk and uncertainty; Education and Learning Wales (2001) stated that risk and uncertainty can be defined as follows:

- Risk exists when a decision is expressed in terms of range of possible outcomes and when known probabilities can be attached to the outcomes.
- Uncertainty exists when there is more than one possible outcome of a course of action but the probability of each outcome is unknown.

In some situations, the risk does not necessarily refer to the chance of bad consequences. There may be the possibility of good consequences, and it is important that a definition of risk includes some reference to this point.

Writers such as Flanagan & Norman (1993) differentiated between risk and uncertainty. *Risk* has place in calculus of probability, and lends itself to quantitative expression. *Uncertainty*, by contrast, might be defined a situation in which there are no historic data or previous history related to the situation being considered by the decision maker. ADB, (2002) stated that in essence, risk is a quantity subject to empirical measurement, while uncertainty is of a non-quantifiable type. Thus, in a risk situation it is possible to indicate the likelihood of the realized value of a variable falling within stated limits—typically described by the fluctuations around the average of a probability calculus. On the other hand, in situations of

uncertainty, the fluctuations of a variable are such that they cannot be described by a probability calculus.

The Royal Society (Greene, 2001) viewed risk as the probability “ *that a particular adverse event occurs during a stated period of time, or results from a particular challenge.*” The Royal Society also states that “ *as a probability in the sense of statistical theory risk obeys all the formal laws combining probabilities*” . The problem with statistical theory is that it is only ever a guess, or an approximation of what is to occur.

Risk can be considered as a “ *systematic way of dealing with hazards*” . If it is assumed that there is uncertainty associated with any prediction of hazard occurring, then there is only uncertainty because there is only ever a prediction of likely. Therefore for risk to exist there must be a hazard. The perception of hazards is entirely subjective. What one person find hazardous, his neighbor may not. This perception of hazard is centered around previous experience, cultural values and to some extent the aspect of specialist training in an area of field of expertise to which the hazard relates (Greene, 2001).

2.2.1 Dynamic and static risks

Dynamic risk is concerned with making opportunities; for instance it might concern developing a new and innovative product. Dynamic risk means that there will be potential gains as well as losses. Dynamic risk is risking the loss of something certain for gain of something uncertain (Flanagan & Norman, 1993) and (NAO, 2001).

Static risk related only to potential losses where people are concerned with minimizing losses by risk aversion (Flanagan & Norman, 1993). The unsystematic and arbitrary management of risks can endanger the success of the project since most risks are very dynamic throughout the project lifetime (Baloi & Price, 2003).

2.3 Causes Of Risk As Threats

There exists no comprehensive study explaining the causes of risks among construction companies, moreover research covering the subject matter has tended to identify the symptoms rather than causes, a number of authors have attempted in their studies to ascertain the causes of threats in the construction industry, Kangari (cited in Rwelamila & Lobelo 1997) ascribed the high threats to:

- A highly fragmented industry.
- Industry highly sensitive to economic cycles.
- Fierce competition as result of an over-capacitated market.
- Relative ease of entry.

- Management problems.
- Trading including:
 - Competitive quoting.
 - Outsize projects.
 - High gearing.
 - Resistance to change.
- Accounting, where inconsistencies occur in the financial data generated for management.
- Increase in project size.
- Unfamiliarity with new geographic area.
- Moving into new type of construction.
- Change in key personnel.

2.4 Sources Of Risks

Checklist of risk drivers (Estate Management Manual, 2001):

- Commercial risk.
- Financial risk.
- Legal risks.
- Political risks.
- Social risks.
- Environmental risks.
- Communications risks.
- Geographical risks.
- Geotechnical risks.
- Construction risks.
- Technological risks.
- Operational risks.
- Demand/product risks.
- Management risks.

These sources of risk relate to project-specific and non-project-specific risks, as both these types of risk need to be considered when identifying the risks in a project or a process. The institution, assisted by the project team, need to define the boundaries of these sources and to break down these sources into detailed risk elements. This will allow a common understanding amongst those attempting to identify the risks in a project.

The division of risks into source elements can be difficult. It also creates the potential for increased personal subjectivity. It can also lead to the possibility of "double-counting" some risks by attributing the same risk to more than one source. This may, however, be beneficial in understanding the relationships between risk sources and elements (Estate Management Manual, 2001). The obvious problem with categorizing risk, apart from the cultural perceptions noted by the royal society report, is that there is a danger of confusing sources, causes, effects and fields of study for the risk domain. A source approach to risk categorizations is shown in Figure (2.1). It is proposed that the risks can be considered with respect to six categories: financial and economic, political and environment, design, site construction, physical and Environmental factors. While the list of potential risks in every category is neither complete nor exhaustive, it does represent the majority of typical project risks and demonstrates the advantage of a logically developed classification scheme (Enshassi & Mayer, 2001).

2.5 Risk Management Process

A number of variations of risk management process have been proposed. Boehm (cited in Raz & Michael, 2001) suggested a process consisting of two main phases: risk assessment, which includes identification, analysis and prioritization, and risk control which includes risk management planning, risk resolution and risk monitoring planning, tracking and corrective action. Chapman and Ward (cited in Tummala & Burchett, 1999) identified risk management approach as a multiphase 'risk analysis' which covers identification, evaluation, control and management of risks. Simmons (1998) provided a definition for the risk management as the sum of all proactive management-directed activities, within a program that is intended to acceptably accommodate the possible failures in elements of the program. "Acceptably" is as judged by the customer in the final analysis, but from a firm's perspective a failure is anything accomplished in less than a professional manner and/or with less than-adequate result. Al-Bahar cited in (Ahmed et al, 1999) defined the risk management as a formal orderly process for systematically identifying, analyzing, and responding to risk events throughout the life of a project to obtain the optimum or acceptable degree of risk elimination or control.

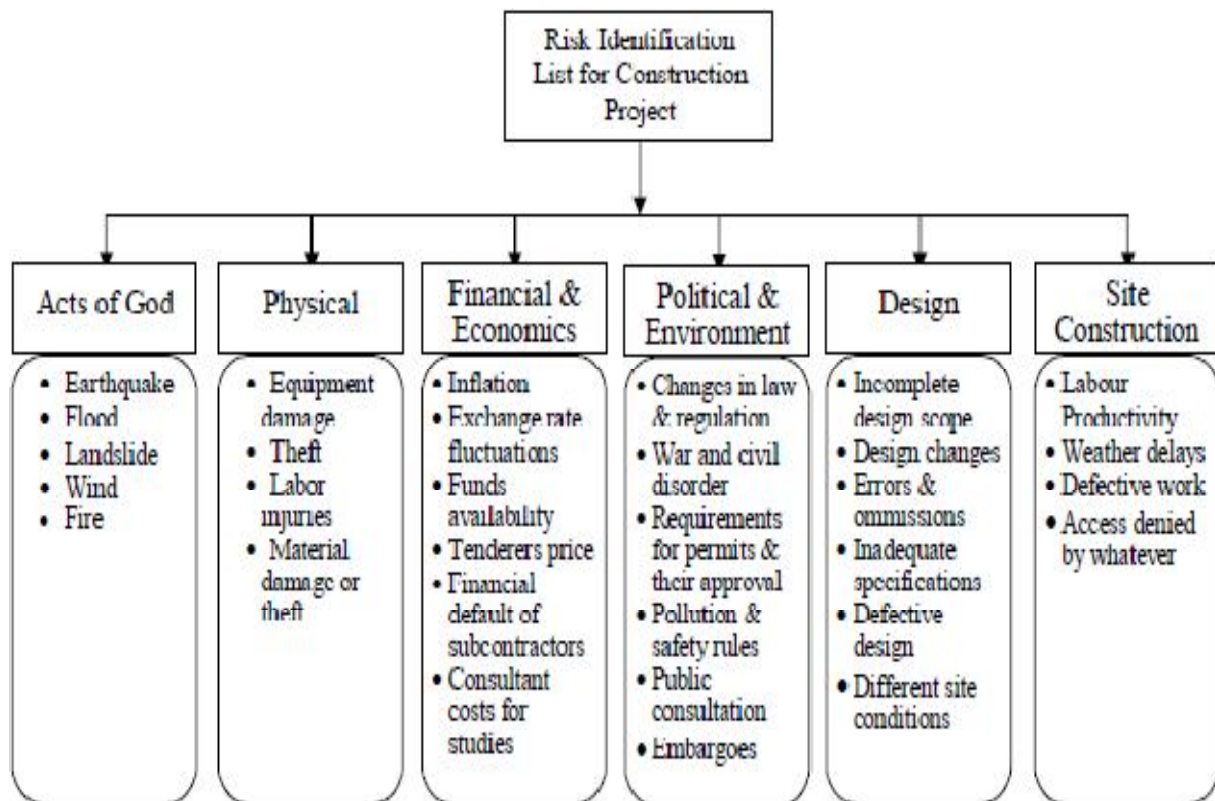


Figure 2.1. Risk Categorization List, adapted from (Enshassi & Mayer, 2001)

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It is possibilities that are being accommodated. It is management's job to do the planning that will accommodate the possibilities. The customer is the final judge, but internal goals should be to a higher level than customer expectations. Risk management as a shared or centralized activity must accomplish the following tasks (Simmons, 1998):

- Identity concerns.
- Identify risks & risk owners.
- Evaluate the risks as to likelihood and consequences.
- Assess the options for accommodating the risks.
- Prioritize the risk management efforts.
- Develop risk management plans.
- Authorize the implementation of the risk management plans.
- Track the risk management efforts and manage accordingly.

Chapman and Ward (1997) outlined a generic risk management process consisting of nine phases:

1. Define the key aspects of the project;
2. Focus on a strategic approach to risk management;
3. Identify where risks may arise;
4. Structure the information about risk assumption and relationships;
5. Assign ownership of risks and responses;
6. Estimate the extent of uncertainty;
7. Evaluate the relative magnitude of the various risks;
8. Plan response;
9. Manage by monitoring and controlling execution.

According to the Project Management Body of Knowledge (PMI,1996), risk management forms one of the so-called nine functions of project management (the other eight being integration, communications, human resources, time, cost, scope, quality and procurement management). The traditional view is that these functions should form the basis of planning and that each should be the focus of attention in each phase of the project. In the PMBOK, PMI (1996) presents four phases of the risk management process: identification quantification, responses development and control. Risk Management covers the process of identification, assessment, allocation, and management of all project risks (APM, 2000). Healy cited in (Shen, 1997) suggested a systematic process including risk identification, risk analysis and risk response, where risk response has been further divided into the four actions: risk retention, risk reduction, risk transfer and risk avoidance. Risk management is also seen as a process that accompanies the project from its definition through its planning, execution and control phases up to its completion and closure (Raz & Michael, 2001). Risk management is not synonymous with insurance, nor does it embrace the management of all risks to which a project is exposed. In practice, the truth lies somewhere between the two extremes. A risk management system must be practical, realistic and must be cost effective. The depth to which you analyze risk obviously depends upon your circumstance. Only you can judge the importance to be placed on a structured risk analysis. Conventional education does little to foster an awareness of how unpredictable reality can be (Flanagan & Norman, 1993). Risk management measures the potential changes in value that will be experienced in a portfolio as a result of differences in the environment between now and some future point in time (Dembo & Freeman, 1998).

2.5.1 Construction risk management approach-Conceptual Model

This model placed risk management in the context of project decision making while considering the over-lapping contexts of behavioral responses, organization structure, and

technology. The objectives of project and construction risk management should be clearly established within the context of project decision-making, and will be governed largely by the risk attitude of the project proponent. In discussing human judgments in decision making, proposes a sociological and organizational context for risk analysis. The construction risk management conceptual model provides an effective systematic framework for quantitatively identifying, analyzing, and responding to risk in construction projects. With this model emphasis is placed on how to identify and manage risks before, rather than after, they materialize into losses or claims (Enshassi & Mayer, 2001).

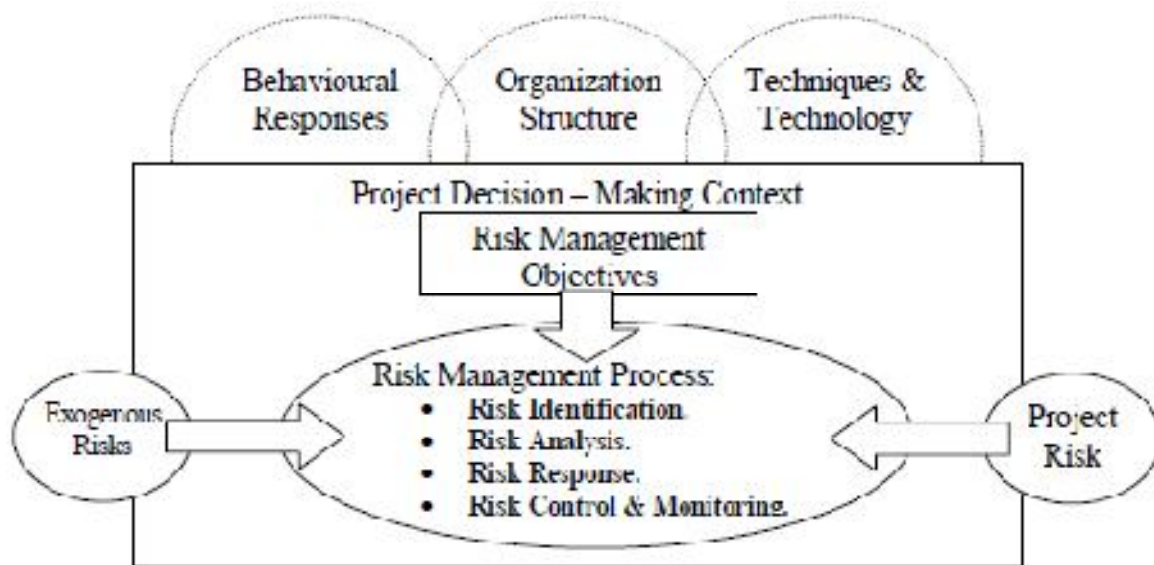


Figure 2.2. Conceptual Model of Construction Risk Management, (Enshassi & Mayer 2001)

2.5.2 Risk Identification

This is the first stage in risk management and it entails capturing all the potential risks that could arise within the project. It is commonly acknowledged that of all the stages of risk management process, risk identification stage has the largest impact on the accuracy of any risk assessment (Chapman, 1998). To facilitate risk identification, risks can also be broadly categorized as controllable and uncontrollable risks (Flanagan and Norman, 1993). Further, controllable risks are those risks which a decision maker undertakes voluntarily and whose outcome is, in part, within our direct control; and uncontrollable risks as those risks which we cannot influence (Chege & Rwelamila, 2000). Risk identification consists of determining which risks are likely to affect the project and documenting the characteristics of each. Risk

identification is not a one time event; it should be performed on a regular basis throughout the project (PMI, 1996). The identification of risks consists of a method used to generate risks, and guidance on what those risks should look like when written down (Isaac, 1995). Risk identification should address both internal and external risks. Internal risks are things that the project team can influence, such as staff assignments and cost estimates. External risks are things beyond the control or influence of the project team, such as government actions. In project context, risk identification is also concerned with opportunities (positive outcomes) as well as threats (negative outcomes) (PMI, 1996). At this stage, a broad view should be taken to ascertain without any constraint the risks that are likely to impede the project in meeting its cost target. A failure to recognize the existence of one or more potential risks may result in a disaster or foregoing an opportunity for gain resulting from proper corrective action (Enshassi & Mayer, 2001). When attempting to identify risk, it is rather like trying to map the world. Maps of the world tend to be centered on the location of the map maker. Much of the world is not visible from where you stand. Some territory which is familiar and obvious to you may not be obvious to everyone. Similarly, looking at a large project from the top, with multiple layers of planning, complex vertical and horizontal interactions, and sequencing problems, resembles looking into the world map through a fog. Management's ability to influence the outcome is limited to what they can see. The great temptation is to focus upon what should happen, rather than what could happen. A clear view of the event is the first equipment, focusing on the sources of risk and effect of the event (Flanagan & Norman, 1993). While extensive catalogues of risk can be devised, these are always likely to be incomplete and therefore inadequate. This may lead to decision-makers failing to consider the full spectrum of potential risks for a project. Developing categories of risk is one way of typifying risks so that this danger can be minimized (Enshassi & Mayer, 2001).

2.5.3 Risk Analysis

Risk analysis, a component of the risk management process, deals with the causes and effects of events which cause harm. The aim behind such analysis is a precise and objective calculation of risk. To the extent that this is possible, it allows the decision making process to be more certain (Estate Management Manual, 2002). The essence of risk analysis is that it attempts to capture all feasible options and to analyze the various outcomes of any decision. For building projects, clients are mainly interested in the most likely price, but projects do have cost over-runs and, too frequently, the 'what if' question is not asked (Flanagan & Norman, 1993).

Risk analysis involves assessing the identified risks. This first requires that the risks are quantified in terms of their effect on cost, time or revenue. They can be analyzed by measuring their effects on the economic parameters of the project or process. In terms of risk response, three general types of response can be identified (Estate Management Manual, 2002):

- Risk avoidance or reduction.
- Risk transfer.
- Risk retention.

The use of risk analysis gives an insight into what happens if the project does not proceed according to plan. When active minds are applied to the best available data in a structured and systematic way, there will be a clearer vision of the risks than would have been achieved by intuition alone (Flanagan & Norman, 1993).

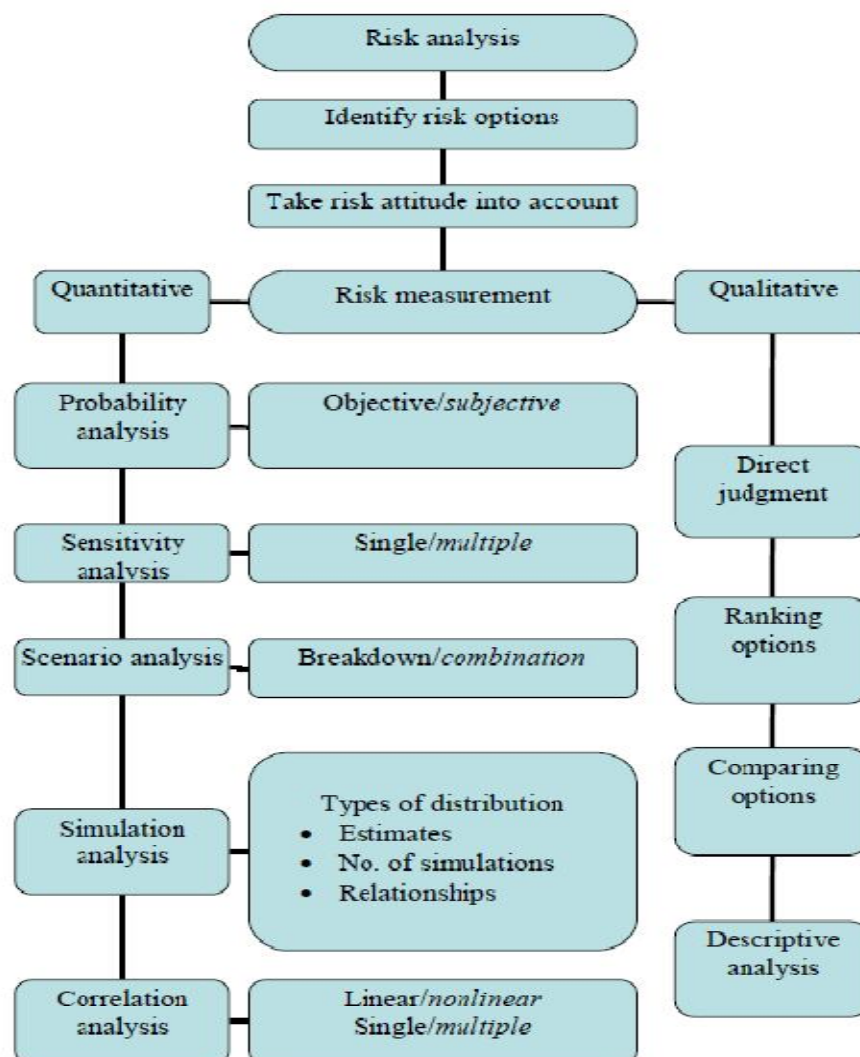


Figure (2.3), detailed by Flanagan and Norman (1993), shows the sequence in risk analysis. The traditional approach to forecasting construction price or construction duration at the design stage of a project is to use the available data and produce a single point best estimate. The risk analysis approach explicitly recognizes uncertainty that surrounds the best estimate by generating a probability distribution based upon expert judgment. Therefore, the understanding about the effects of uncertainty upon the project will be improved. Risk analysis must not be viewed as a stand alone activity; any strategies developed must not be seen as cast in stone commandments. Rather, these should be seen as a component of all decisions made continually to respond to project dynamics (Jaafari, 2001). Risk analysis involves evaluating risks and risk interactions to assess the range of possible project outcomes. It is complicated by a number of factors including, but not limited to (PMI, 1996):

- Opportunities and threats can interact in unanticipated ways (e.g., schedule delays may force consideration of new strategy that reduces overall project duration).
- A single risk event can cause multiple effects, as when late delivery of a key material produces cost overruns, schedule delays, penalty payments, and a lower quality product.
- The mathematical techniques used can create a false impression of precision and reliability.

What is needed is an application of risk analysis to help project managers control cost that is relatively simple to apply, can be used throughout the life cycle of a construction project, accounts for the tendency of construction professionals to apply risk in linguistic terms, and apply their experience (Bender & Ayyub, 2001).

2.5.3.1 Methods of Risk Analysis

The analysis of risks can be *quantitative* or *qualitative* in nature depending on the amount of information available (APM, 2000). Qualitative analysis focuses on identification together with assessment of risk, and quantitative analysis focuses on the evaluation of risk (Chapman, 2001). Indeed there may be so little information about certain risks that no analysis is possible.

2.5.3.1.1 Qualitative Risk Analysis

Lowe (2002) introduced a definition for the qualitative assessment of risk involves the identification of a hierarchy of risks, their scope, factors that cause them to occur and potential dependencies. The hierarchy is based on the probability of the event and the impact on the project. In qualitative risk analysis risk management acts as a means to registering the properties of each risk (Kuismanen et al, 2002). Qualitative risk analysis assesses the

importance of the identified risks and develops prioritized lists of these risks for further analysis or direct mitigation. The management team assesses each identified risk for its probability of occurring and its impact on project objectives. Sometimes experts or functional units assess the risks in their respective fields and share these assessments with the team (Office of project management process improvement, 2003). Components of risk analysis were introduced by Kindinger and Darby (2000):

- List activities, tasks, or elements that make up the project.
- Identify applicable risk factors.
- Develop risk-ranking scale for each risk factor.
- Rank risk for each activity for each risk activity.
- Document the results and identify potential risk-reduction actions.

• Qualitative Risk Ranking Guidelines

A method to systematically document the risk for each qualitative risk factor identified in Figure (2.4) is needed to perform a consistent evaluation of risk across the different project or program activities. To make this possible, qualitative definitions of risk factors are defined for three categories of risk (none/low, medium, and high). A simple example of a completed evaluation is shown in Figure (2.5).

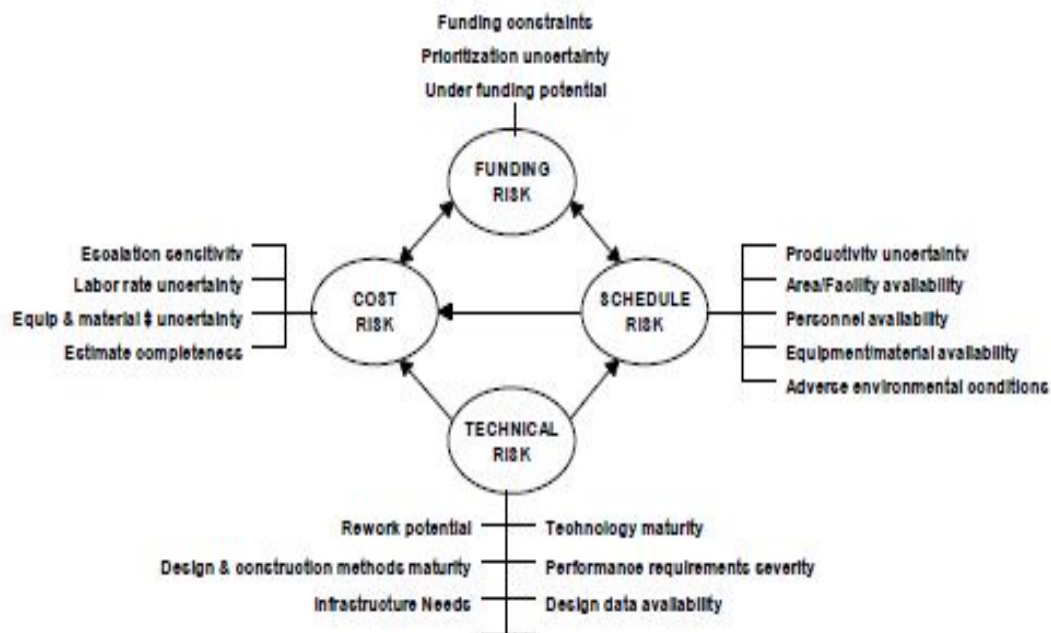


Figure 2.4. Qualitative Risk Factor Ranking Criteria, adopted from (Kindinger & Darby, 2000)

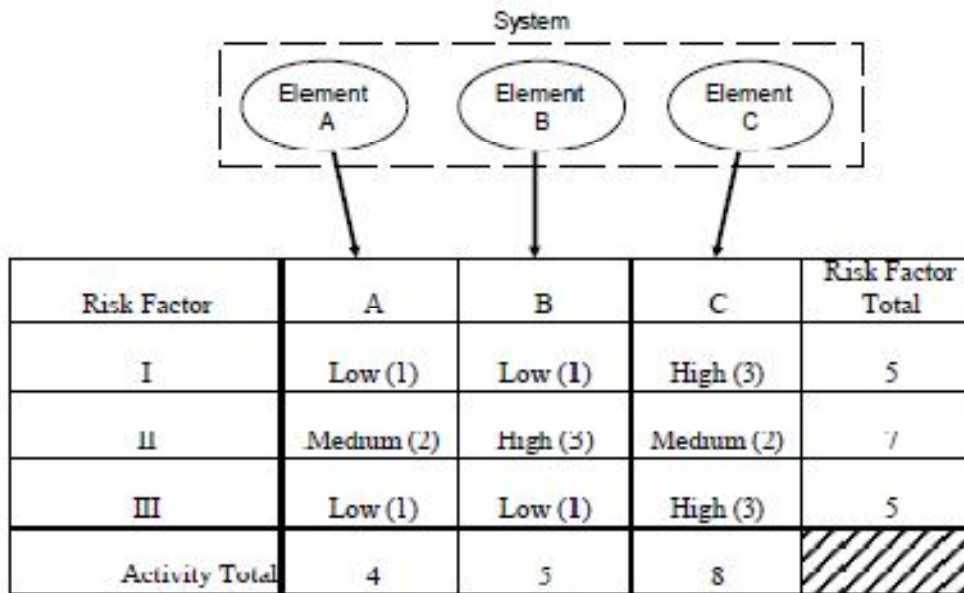


Figure 2.5. Risk Factor Evaluation, (Kindinger & Darby, 2000)

- **Uses of Qualitative Risk analysis Results**

Qualitative risk analysis results are used to aid the project management team in three important ways (Kindinger & Darby, 2000):

- The qualitative risk analysis factor rankings for each project activity provide a first-order prioritization of project risks before the application of risk reduction actions. This general ranking process is shown in Figure (2.5).
- The more meaningful, result from conducting a qualitative risk analysis is the identification of possible risk-reduction actions responding to the identified risk factors. Risk reduction recommendations are often straightforward to make when the risk issue is identified.
- The final use of the qualitative risk analysis is the development of input distributions for qualitative and quantitative risk modeling. The integrated qualitative and quantitative risk analysis is shown below in Figure (2.6).

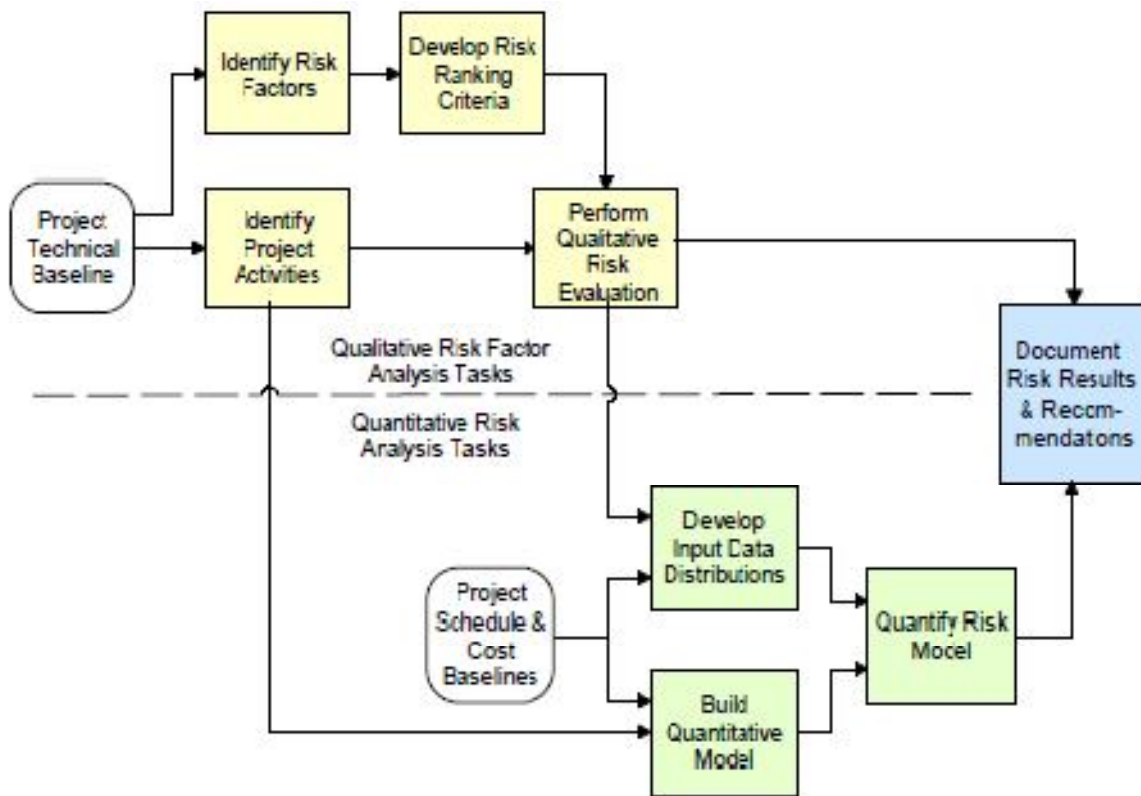


Figure 2.6. Integrated qualitative and quantitative risk analysis, (Kindinger & Darby, 2000)

2.5.3.1.2. Quantitative Risk Analysis

Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impact of all identified and quantified risks. The result is a probability distribution of the project's cost and completion date based on the risks in the project (Office of Project Management Process Improvement, 2003). The quantitative methods rely on probability distribution of risks and may give more objective results than the qualitative methods, if sufficient current data is available. On the other hand, qualitative methods depend on the personal judgment and past experiences of the analyst and the results may vary from person to person. Hence the quantitative methods are preferred by most analysts (Ahmed et al, 2001). Quantitative risk analysis considers the range of possible values for key variables, and the probability with which they may occur. Simultaneous and random variation within these ranges leads to a combined probability that the project will be unacceptable (Asian

Development Bank, 2002). Quantitative risk analysis involves statistical techniques that are most easily used with specialized software (Office of Project Management Process Improvement, 2003). Quantitative risk analysis is to assign probabilities or likelihood to the various factors and a value for the impact then identify severity for each factor (Abu Rizk, 2002). When thorough quantitative risk analysis is necessary it can take two alternative approaches (Kuismanen, 2001):

1. risks can be quantified as individual entities while looking at the big picture. This way can include the cumulative effects (to certain accuracy) into each individual risk and thus make more accurate estimations of the net value of the risks.

2. Alternatively modeling the mathematical properties of the interrelations from the bottom up can be started and then calculate the net impact of each risk including the effects of interrelations.

In Figure 2.7 the basic steps of a quantitative risk analysis and a simplified relationship between risk analysis, risk assessment and risk management is presented (Abrahamsson, 2002).

• **Basic Steps of Quantitative Risk Analysis**

As discussed previously, the aim of risk analysis is to determine how likely an adverse event is to occur and the consequences if it does occur. When quantitative risk analysis is to be done, it is attempted to describe risk in numerical terms. To do this, it should go through a number of steps (Kelly, 2003):

1. Define the consequence; define the required numerical estimate of risk.
2. Construct a pathway; consider of all sequential events that must occur for the adverse event to occur.
3. Build a model - Collect data; consider each step on the pathway and the corresponding variables for those steps.
4. Estimate the risk; once the model has been constructed and the data collected the risk can be estimated. Included in this estimation will be an analysis of the effects of changing model variables to reflect potential risk management strategies.
5. Undertake a sensitivity and scenario analysis; Undertaking a risk analysis requires more information than for sensitivity analysis.

• **Methods of Quantitative Risk Analysis**

Any specific risk analysis technique is going to require a strategy. It is best to begin by providing a way of thinking about risk analysis that is applicable to any specific tool might be used.

- *Probability Analysis* is a tool in investigating problems which do not have a single value solution, Monte Carlo Simulation is the most easily used form of probability analysis.
- *Monte Carlo Simulation* is presented as the technique of primary interest because it is the tool that is used most often.
- *Sensitivity Analysis* is a tool that has been used to great extent by most risk analysts at one time to another.
- *Breakeven Analysis* is an application of a sensitivity analysis. It can be used to measure the key variables which show a project to be attractive or unattractive.
- *Scenario Analysis* is a rather grand name for another derivative of sensitivity analysis technique which tests alternative scenarios; the aim is to consider various scenarios as options.

Sensitivity Analysis and Monte Carlo Simulation are discussed briefly:

• **Sensitivity Analysis**

Sensitivity analysis is a deterministic modeling technique which is used to test the impact of a change in the value of an independent variable on the dependent variable. Sensitivity analysis identifies the point at which a given variation in the expected value of a cost parameter changes a decision. Sensitivity analysis is performed by changing the values of independent risk variables to predict the economic criteria of the project (Merna & Stroch, 2000). Sensitivity analysis is an interactive process which tells you what effects changes in a cost will have on the life cycle cost (Flanagan & Norman, 1993). Sensitivity Analysis is the calculating procedure used for prediction of effect of changes of input data on output results of one model (Jovanovich, 1999). It does not aim to quantify risk but rather to identify factors that are risk sensitive. Sensitivity analysis enables the analyst to test which components of the project have the greatest impact upon the results, thus narrowing down the main simplicity and ability to focus on particular estimates (Flanagan & Norman, 1993). The advantage of sensitivity analysis is that it can always be done to some extent. Specific scenarios of interest can be reasonably well described. Extreme outcomes, like the maximum or minimum possible costs, can often be estimated.

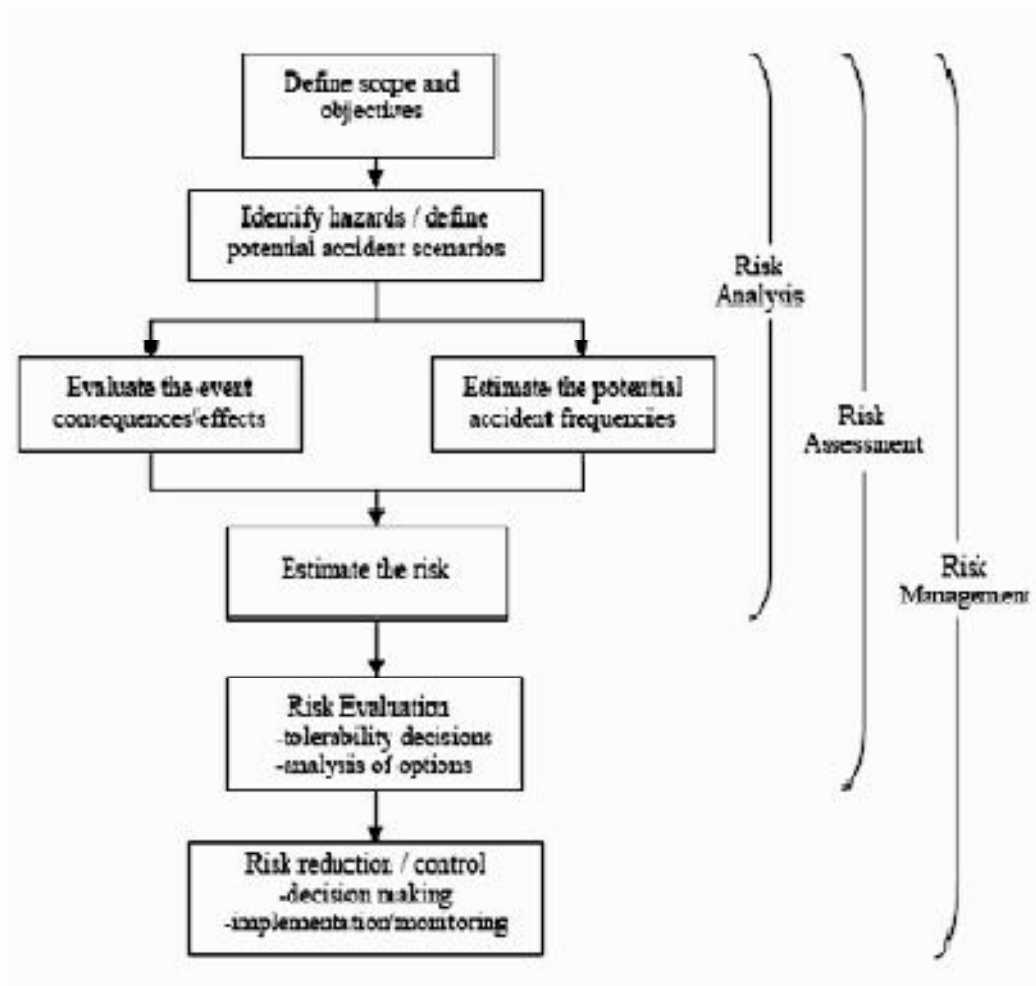


Figure 2.7. Simplified relationship between risk analysis, risk assessment and risk management. Adapted from Abrahamsson (2002).

The major disadvantage of sensitivity analysis is that the analyst usually has no idea how likely these various scenarios are. Many people equate possible with probable, which is not the case with sensitivity analysis (Yoe, 2000).

• Monte Carlo Simulation

Simulation is a probability-based technique where all uncertainties are assumed to follow the characteristics of random uncertainty. A random process is where the outcomes of any particular process are strictly a matter of chance (Flanagan, 2003). The Monte Carlo process is simply a technique for generating random values and transforming them into values of interest, the methods of generating random or pseudo random numbers are more sophisticated now and the mathematics of other distributions is more complex (Yoe, 2000). Different values of risk variables are combined in a Monte Carlo simulation. The frequency of occurrence of a particular value of any one of the variables is determined by defining the probability distribution to be applied across the given range of values. The results are shown as frequency and cumulative frequency diagrams. The allocation of probabilities of occurrence to each risk requires the definition of ranges for each risk (Merna & Stroch, 2000). Lukas (2004) presented risk analysis simulation steps:

1. Start with a project estimate done for each cost account.
2. Decide on the most likely cost, pessimistic costs, and optimistic costs.
3. Insert data into simulation software, then run the model.
4. Determine contingencies based on desired risk level.
5. Prioritize □risky□ cost accounts for risk response planning.

This method of sampling (i.e. random sampling) will, lead to over- and under-sampling from various parts of the distribution. In practice, this means that in order to ensure that the input distribution is well represented by the samples drawn from it, a very large number of iterations must be made. In most risk analysis work, the main concern is that the model or sampling scheme we use should reproduce the distributions determined for the inputs (Abrahamsson, 2002). On the other hand, Lukas (2004) stated some of the simulation benefits:

- Improves estimate accuracy, it helps determine a contingency plan for an acceptable level of risk.
- Helps determine the bigger cost risks for risk response planning.

2.6 Risk Response Practices

PMI (1996) suggested three ways of responding to risk in projects, they are as follows:

- Avoidance: eliminating a specific threat, usually by eliminating the cause. The project management team can never eliminate all risks, but specific risk events can often be eliminated.

- Mitigation: reducing the expected monetary value at risk events by reducing the probability of occurrence (e.g., using new technology), reducing the risk event value (e.g., buying insurance), or both.
- Acceptance: accepting the consequences. Acceptance can be active by developing a contingency plan to execute should the risk event occur or passive by accepting a lower profit if some activities overrun.

Abu Rizk (2003) suggested some actions to be taken in response to residual risks. Actions can include:

- Reduce uncertainty by obtaining more information, this leads to re-evaluation of the likelihood and impact.
- Eliminate or avoid the risk factor through means such as a partial or complete redesign, a different strategy or method etc.
- Transfer the risk element by contracting out affect work.
- Insure against the occurrence of the factor.
- Abort the project if the risk is intolerable and no other means can be undertaken to mitigate its damages.

Ahmed et al (2001), Akintoyne and MacLeod (1997), Enshassi and Mayer (2001), and Education and Learning Whales (2001) argued that there are four distinct ways of responding to risks in a construction project, namely, risk avoidance, risk reduction, risk retention and risk transfer. Those ways are discussed in below briefly.

2.6.1 Risk Avoidance

Risk avoidance is sometimes referred to as risk elimination. Risk avoidance in construction is not generally recognized to be impractical as it may lead to projects not going ahead, a contractor not placing a bid or the owner not proceeding with project funding are two examples of totally eliminating the risks. There are a number of ways through which risks can be avoided, e.g. tendering a very high bid; placing conditions on the bid; pre-contract negotiations as to which party takes certain risks; and not bidding on the high risk portion of the contract(Flanagan & Norman, 1993).

2.6.2 Risk Transfer

This is essentially trying to transfer the risk to another party. For a construction project, an insurance premium would not relieve all risks, although it gives some benefits as a potential loss is covered by fixed costs (Tummala & Burchett, 1999)

Risk transfer can take two basic forms:

- The property or activity responsible for the risk may be transferred, i.e. hire a subcontractor to work on a hazardous process;
- The property or activity may be retained, but the financial risk transferred, i.e. by methods such as insurance and surety.

2.6.3 Risk Retention

This is the method of reducing controlling risks by internal management (Zhi, 1995); handling risks by the company who is undertaking the project where risk avoidance is impossible, possible financial loss is small, probability of occurrence is negligible and transfer is uneconomic (Akintoyne & MacLeod, 1997). The risks, foreseen or unforeseen, are controlled and financed by the company or contractor. There are two retention methods, *active* and *passive*;

- a. **Active retention** (sometimes referred to as self-insurance) is a deliberate management strategy after a conscious evaluation of the possible losses and costs of alternative ways of handling risks.
- b. **Passive retention** (sometimes called non-insurance), however, occurs through negligence, ignorance or absence of decision, e.g. a risk has not been identified and handling the consequences of that risk must be borne by the contractor performing the work.

2.6.4 Risk Reduction

This is a general term for reducing probability and/or consequences of an adverse risk event. In the extreme case, this can lead to eliminate entirely, as seen in risk avoidance. However, in reduction, it is not sufficient to consider only the resultant expected value, because, if potential impact is above certain level, the risk remains unacceptable. In this case, one of the other approaches will have to be adopted (Piney, 2002).