Broadleaf

Creating value from uncertainty

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Resource:
Linking and integrating different views of project risk

Qualitative and quantitative views of project risk are often treated as if they are distinct from one another. It is easier to make sense of uncertainty if that artificial divide is set aside. This paper describes a way to frame processes based on qualitative and quantitative descriptions of uncertainty as an integrated view of project risk management. This can be used to assist in implementing risk management and as an aid to clear communication about project risk.

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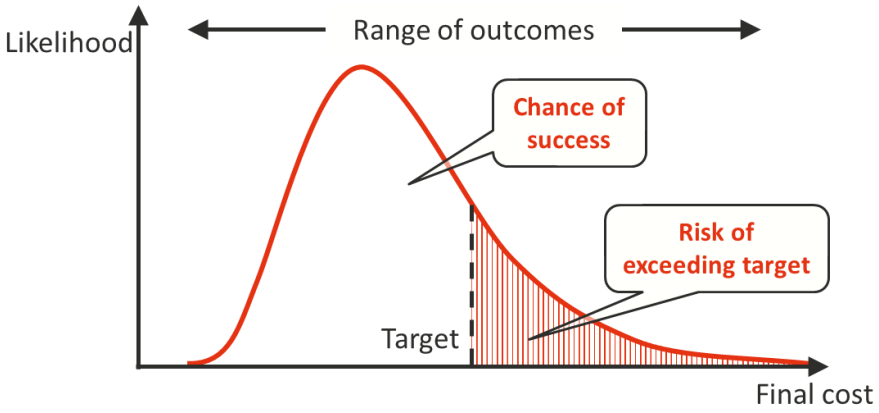
1 Introduction

Qualitative and quantitative views of project risk are often treated as if they are distinct from one another. It is easier to make sense of uncertainty if that artificial divide is set aside. This paper describes a way to frame processes based on qualitative and quantitative descriptions of uncertainty as an integrated view of project risk management. This can be used to assist in implementing risk management and as an aid to clear communication about project risk.

2 Views of uncertainty

Project uncertainty can be described in quantitative terms and drawn together in a model that produces information of the form shown in Figure 1.

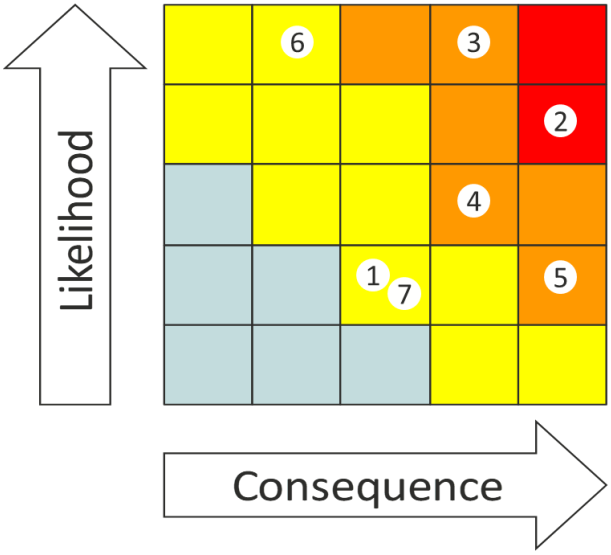
Figure 1: Aggregate project cost uncertainty



Major areas of concern can also be described in qualitative terms, risk descriptions that can be thought of as summaries of possible future scenarios a project could encounter. These might be represented as a simple list or illustrated using a consequence-likelihood table such as the one shown in Figure 2.[1]

[1] There are technical objections to using frameworks such as this, sometimes called heat maps, for quantitative analysis. However, they are a valuable tool for making sense of qualitative descriptions and assessments of risks that many organisations find extremely useful and it is this role for the matrix that is referred to here.

Figure 2: Summary of project risks



There are many ways that the relationship between these two characteristic approaches is commonly addressed, including:

1. Treating them as completely separate exercises
2. Regarding a qualitative analysis as an introductory overview that precedes and possibly informs a quantitative analysis
3. Positioning a qualitative understanding of uncertainty as a subset of quantitative analysis, usually converting qualitative risk descriptions into risk events in a quantitative analysis with a probability of occurrence and an assessment of their impacts if they do occur
4. Converting the qualitative combination of consequence and likelihood assessments into an arithmetic formula, often multiplying scale values used to represent discrete levels of consequence and likelihood.

Treating the two viewpoints as separate, approach 1, is wasteful. There is valuable information to be gained by understanding the relationship between them. Using a qualitative risk assessment as a precursor to a quantitative analysis in approach 2 goes some way towards capturing the value of this information but, in the absence of a structure, it will only ever be informal and lacks rigour.

Insisting that the items in a risk register should be used as components of a quantitative model, often as events with a probability and impact, lays an analysis based on approach 3 open to many pitfalls. These are discussed in the papers *Weaknesses of common project cost risk modelling methods* and *The real risk to your project budget*.

Approach 4, using arithmetic to combine consequence and likelihood scores based on ordinal (ranking) scales with numbers attached to them, is fundamentally flawed because it encourages misuse of the analysis. Once ratings are converted to numerical values, many people assume that these values can be used in further calculations. Common mistakes include adding up all the separate risk ratings to obtain a so called 'project risk rating', believing that a risk with a rating half the value of another risk, for instance, is 50% less important than the other risk, and converting rating values into dollar amounts with arbitrary factors.

None of these common approaches to dealing with the relationship between qualitative and quantitative views of uncertainty is rigorous or effective.

3 An integrated view

To make sense of the relationships between qualitative and quantitative views of uncertainty, it is useful to separate important activities that make up project risk management. The standard ISO 31000 offers a useful level of granularity in its description of the component parts of a risk management process and meaningful relationships between them (Figure 3).

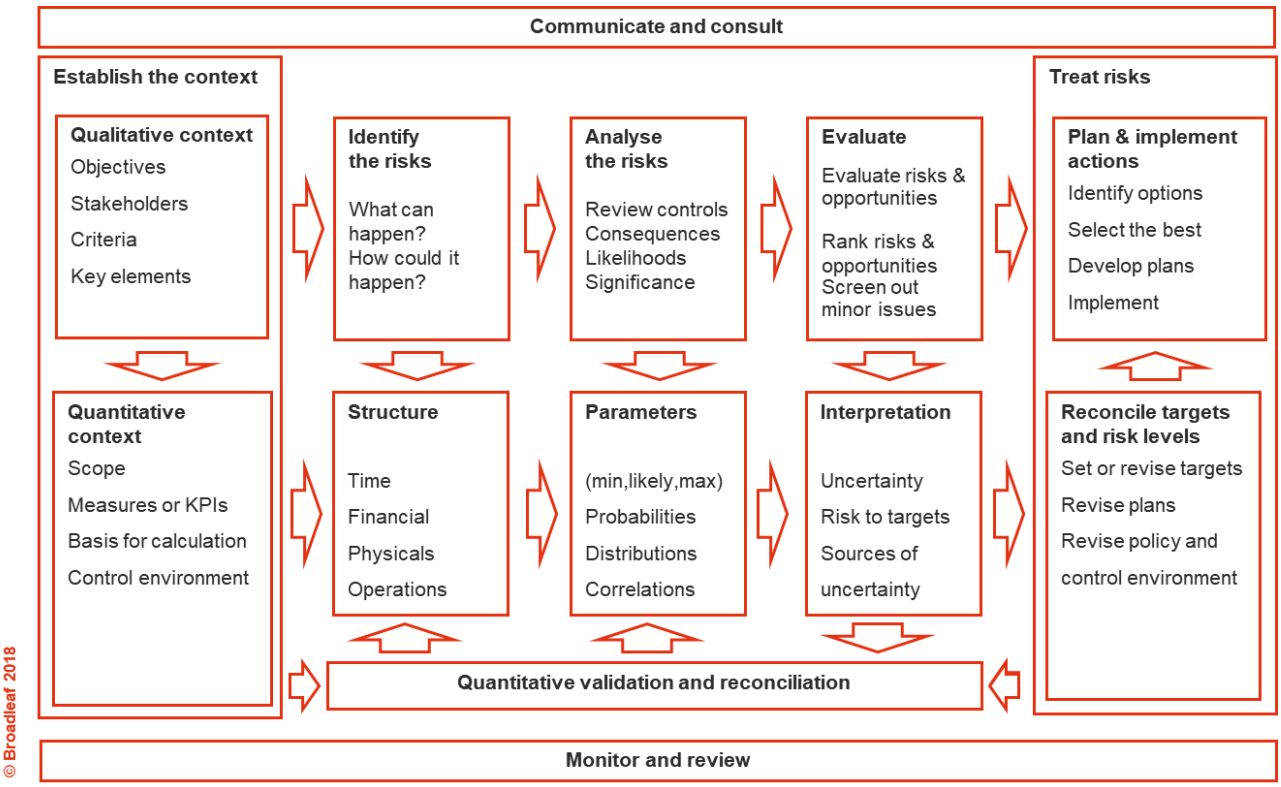
Figure 3: ISO 31000 process outline

While this diagram is often interpreted as if it only relates to qualitative analysis, the standard is generic, and the components shown in the diagram are equally useful for quantitative analysis of project uncertainty. A sound analysis must be grounded in an understanding of the context of a project. It is

necessary to identify what will be included in a model before gathering numerical inputs, establishing the context. After inputs have been processed, interpretation and checking are essential, evaluation, and none of this is of any use unless it is followed by actions, treatment.

Broadleaf's extensive experience with many aspects of risk management led us to an extension of Figure 3, which is shown in Figure 4.

Figure 4: An integrated view



The five blocks across the top are the familiar components of the standard approach. The five corresponding elements across the lower part of the diagram and the additional item labelled 'Quantitative validation and reconciliation' cover a quantitative analysis and management process.

The horizontal flow across the lower part of the diagram is more or less self-explanatory. The connection between the levels, indicated by the downward arrows are the key to the integration of a qualitative and quantitative view of uncertainty. The connections between the two levels offer both a procedural guide to using a qualitative analysis to help build up a quantitative analysis and a mechanism for using each viewpoint to validate and refine the other.

3.1 Establishing the context

The information generated by establishing the context for a qualitative analysis is a natural precursor to defining the scope, metrics and background for the quantitative analysis. Checking back from the quantitative analysis to the qualitative context, if there is a sense that a quantitative characteristic of a project is a crucial measure of success and yet it has not been reflected in the initial establishment of the context for a qualitative assessment, it would be prudent to examine this mismatch. It might be that the matter is not after all as important as had been assumed, which will help focus attention on the true priorities in the quantitative analysis, or that it has been overlooked in one view of project uncertainty and should be included in both.

3.2 Risk identification and model structure

Knowing the main areas of concern in a project is a good guide to understanding how a quantitative risk model should be structured. Risk models are generally built using relatively high-level summaries of project costs and the activity network. A sense of where the uncertainties lie, derived from a qualitative assessment, is a valuable guide to understanding what the model will have to represent. This can assist in deciding where to include detail and where to summarise, what interactions and dependencies to build into the model and where correlations between uncertain factors might be important.

The relationship between risks identified in the qualitative approach and the structure of a quantitative risk model is close but not, as some assume, one-to-one. Several risk descriptions produced in a qualitative analysis might be encompassed in a single component of a quantitative analysis and several components of a risk model might each correspond to more than one high level risk description.

For instance, outstanding design decisions and uncertainty about the environment in which a project is to be implemented could affect the quantities of the materials required. This might be represented in a model by a single distribution or probability density function describing the possible effect of quantity variation on related costs such as bulk material supply, labour costs, plant costs, and contractor's overheads. In that case, many components of the qualitative view will be linked to one component of the quantitative view.

Conversely, there might be many consequences that can flow from a delay to a major external dependency, such as a critical delivery to a project. In the

qualitative description of uncertainty this might be summarised in a single statement about that delivery being delayed. In a model, that delay might be linked to several costs and consequent delays in other areas. In that case one component of the qualitative view will be linked to multiple components of the quantitative view.

In this many-to-many relationship, any gaps are an indication that one of the viewpoints might be incomplete. If a risk has been described in the qualitative assessment and there is nothing in the quantitative analysis that represents its role in the project, the model might be deficient. On the other hand, if the quantitative analysis includes a source of uncertainty that has not been described in the qualitative analysis, the qualitative analysis might be incomplete.

3.3 Qualitative analysis and model parameters

The correspondence between the analysis and rating of risks in a qualitative process and the magnitude of uncertainties in a model is not as clear cut as the correspondence between the list of risks identified in a qualitative analysis and the structure of a model. However, it is another way to check the integrity of each of the two viewpoints and a guide to the possible magnitude of uncertainties and risks' consequences.

From a qualitative assessment, those involved in a project will gain some sense of which uncertainties are the most significant and, separately, from the analysis of a quantitative model they will have a view of their magnitude in terms of time, money or other real world measures. If one viewpoint presents a different impression from the other about the significance of various sources of uncertainty in a project, exploring the discrepancy will often yield valuable insights.

There may be a valid reason for a difference between the two viewpoints, which in itself is often useful information. On the other hand, it might be that an erroneous impression of the uncertainty has become embedded in one or the other analysis and this can be corrected.

3.4 Evaluation and interpretation

When the overall impression of a project is formed by looking at all the risk descriptions and ratings, it can be compared with the overall outcome of a quantitative analysis. As with the comparison of individual risk analyses and

parameters, an overall comparison such as this provides a means of confirming the validity of both viewpoints. If there are significant differences, exploring them should improve the quality of both analyses and confirm the confidence that can be placed in their conclusions.

3.5 Quantitative reconciliation and treatment

Quantitative analysis is sometimes the key to understanding whether a project is a worthwhile investment at all. Understanding when there is a need for a significant revision of costs, or the sequencing of work and allocation of resources, might set the envelope within which detailed treatment planning is carried out. Even when a quantitative analysis confirms the viability of a project, understanding the areas of the cost and the schedule that are under the greatest stress is a useful guide to decision making about treatment actions.

3.6 Validation and reconciliation

The validation activity shown at the centre of the lower edge of the main diagram, below and connected to the components labelled structure, parameters and interpretation, is a vital step in quantitative modelling.

A human observer will rarely be able to confirm the relationship between the aggregate effect of inputs and the outputs generated by a quantitative analysis in even the most straightforward and transparent model. However, by reviewing the evaluation and interpretation of the project as a whole, setting this against skilled and experienced judgement about the project, and testing the sensitivity of the outcomes to the inputs, it is possible to check that the model makes sense.

If a very large contribution to the difference between the base estimate and a probabilistic assessment of cost, perhaps its mean value or the value of a selected percentile point in the distribution, comes from a minor area of work, it might be a sign that there is an error in the model. Similarly, if the sensitivity of the variation in output values to the variation in input values, perhaps assessed using a correlation analysis, is inconsistent with a general understanding of which sources will be most significant, this will usually be worth exploring.

It is vital to view quantitative risk modelling as an iterative process: developing a conceptual model, defining the input parameters it requires, gathering input assessments, examining outputs, validating the results and revising the model

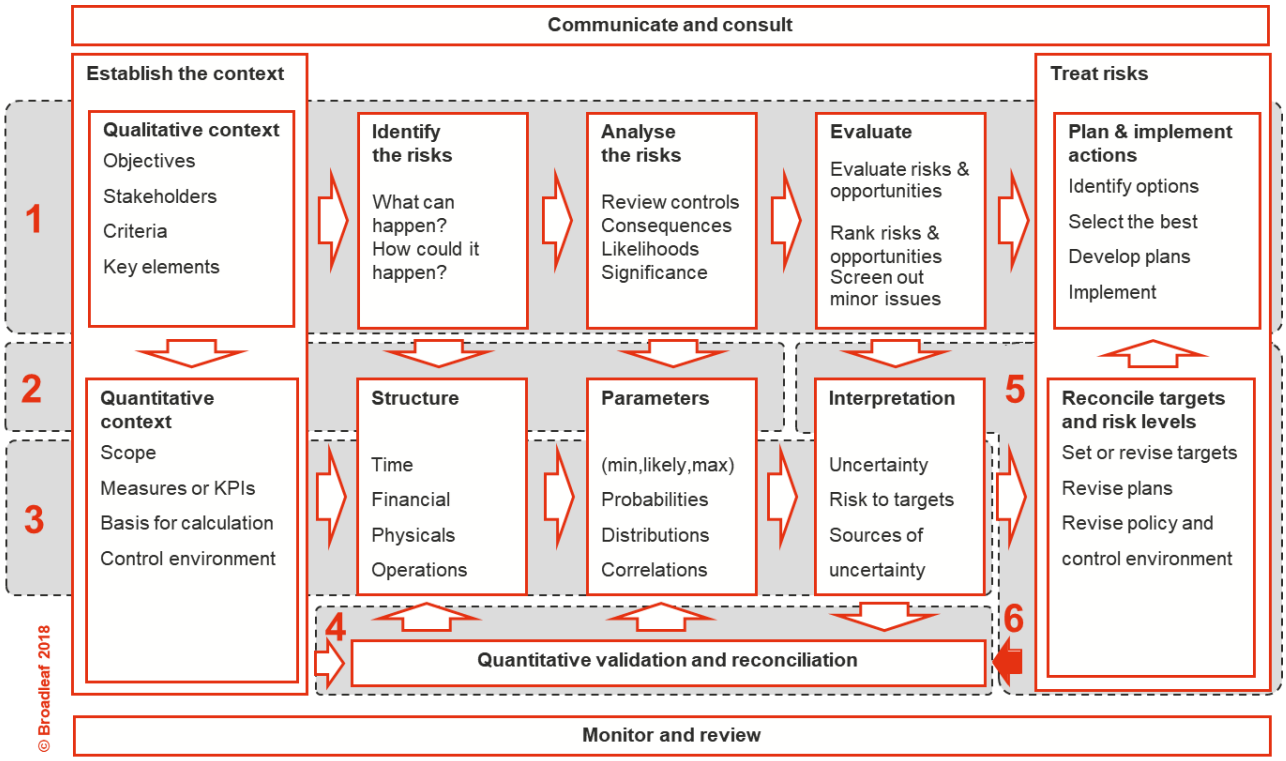
structure or inputs as required, and generating fresh outputs to ensure that it makes sense. This process can help expose simple errors and bugs in a model. It will also often expose misconceptions and biases that have been incorporated into the model structure or parameters.

4 Planning analysis tasks

In addition to helping make sense of the relationship between different views of project uncertainty, the structure in Figure 4 can be used to plan an integrated approach to initiating or reviewing risk management for a project. There is a natural order to the matters to be addressed that can be used to help develop a plan for the work.

The shaded areas in Figure 5 represent six stages that can be used to work through a full analysis. They ensure that tasks are addressed in sequence, so that information is created or collected before the tasks that need it are undertaken.

Figure 5: Sequence of analysis



Stage 1 is the standard approach to initiating risk management used by many. It is a complete pass from establishing the context to examining treatment options.

Stage 2 represents the conventional approach to planning a risk modelling exercise. It is intended to encompass developing the model structure and defining the parameters to be evaluated as inputs but not actually evaluating the parameters at this stage. Once the required parameters are identified, an exercise to gather information (Stage 3) can be planned.

Stage 3 represents the actual quantitative assessment exercise, possibly allowing for revisions of the model structure as discussions proceed, and including assessing ranges of uncertainties, probabilities of events and correlations between factors, leading to the production of initial outputs.

Stage 4 is a critical review of the outcome of the model and the relationships between inputs and outputs. It will usually include both an examination of the model results and sensitivity analyses to test the relationship of inputs to outputs and the balance between separate areas of risk. Subject to the outcome of this review, the model structure and parameter values might be revised.

Stage 5 represents the use of the model outcomes and the insights gained from sensitivity analyses to make decisions about whether the project plan should be reviewed and where further action should be directed to maximise value and the chances of success.

Stage 6 draws attention to the fact that, as treatment actions are formulated and implemented, the analysis should be reviewed to ensure that it remains current and to check the likely efficacy of the actions being implemented.

5 Conclusion

Qualitative and quantitative views of project risk are framed in different terms but they simply represent the same information in different ways. It is possible to understand the relationships between them in a way that enhances both viewpoints and provides a basis for planning a systematic analysis.

The relationships can also be used to assist with clear communication about project risk, using the qualitative and quantitative expressions of the factors at work to support and reinforce one another.

6 Contacts

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