Management of risk affects the success and financial viability of a project. Internal risks, which are generally within the control of a construction organisation, are cost and schedule overrun. External risks include market conditions, government policy and natural disasters.

This article describes the management of internal risks through integrated schedule and cost analysis as these are areas that can be managed effectively by a construction organisation with minimal set up cost.

The types of project referred to in this article can either be design-and-build or build-only projects. Other forms of procurement such as Build-Operate-Transfer (BOT) will attract different risks which are not considered herein.

**Risks**

**What is risk?**

One of the more widely adopted definitions of project risk comes from the Project Management Institute (PMI):

“Risk is an uncertain event or condition that, if occurs, has an effect on at least one project objective. Objective can include scope, schedule, cost and quality. A risk may have one or more causes, and if it occurs, it may have one or more impacts. A cause may be a requirement, assumption, constraint, or condition that creates the possibility of negative or positive outcomes” (PMI 2012).

**Why do we want to identify and prioritise risks?**

In many cases, even though the project anticipates it will yield adequate profits on timely completion, projects that exceed the budgeted cost and scheduled time may be due to failure to identify, prioritise and manage risks which may significantly affect cashflow and resources during execution of the works.

Where oversight arises from a corporate culture that leans towards optimistic rather than realistic cost and schedule estimates, there is a tendency to ignore or underestimate the presence and impact of serious project risks that requires adequate analysis and management.

**Responses to high-priority risks**

Once the project risks have been identified and prioritised, the organisation should seek to develop options and actions to either enhance opportunities or reduce the threats from these high-priority risks to enable successful realisation of the project objectives. This could be achieved by using an integrated analysis of the risk impact on both the schedule and cost.

The strategies for managing risk typically are: 1) avoid; 2) transfer; 3) mitigate or; 4) accept.

The first three strategies are more commonly deal with threats or risks that may have negative impacts on project objectives if they occur.

Avoidance may be the best way to deal with risks when no alternative is available. More often than not, the risks are not identified early enough to implement this strategy.

Transfer of risk could be in the form of contractual arrangements as well as insurance.

Mitigation measures are designed to reduce the probability and/or impact of an adverse risk event and allow it to be managed within an acceptable threshold.

Acceptance can be used for negative risks or threats as well as positive risks or opportunities as it is seldom possible to eliminate all threats from a project. Such risk exists because it is unforeseeable or there is a lack of appropriate response strategy at the point of review. Contingency reserve caters for such a risk which requires no action until it eventuates.

**Common project risks**

Some of the common project risks are as follow:

1. **Scope risk**: The scope of work is poorly or ill-defined; conflicting requirements resulting in failure to integrate; unexpected changes in the Employer’s requirements.

2. **Schedule risk**: Heavy reliance on third parties such as sub-contractors, suppliers; inaccurate resources and productivity estimates; constraints such as contract procedural compliance, design coordination, procurement, services diversions, testing and commissioning.

3. **Resource risk**: Outsourcing (such as sub-contractors, suppliers); attrition and/or availability of resources.

4. **Cost risk**: Cost fluctuations; cashflow; underpricing or errors in pricing.
Integrated Analysis of Schedule and Cost Risk

With appropriate responses to the high-priority risks in place, corresponding resources and activities also need to be allocated into the project management plan.

The responses adopted should be cost effective in meeting the challenge and realistic.

The common project risks are best managed as follows:

1. **Scope risk**: With the aid of Work Breakdown Structure (WBS), the scope is broken down into manageable elements.

2. **Schedule risk**: Through proper and experienced planning, risk events and allowances are incorporated into the schedule and effectively monitored and managed.

   Historical data can be used to establish the best estimated duration for each task in conjunction with appropriate resources and productivity rates.

   Establishing logical links between activities so that critical path analysis can be meaningful, and the risks along it may be managed through an appropriate strategy.

3. **Resource risk**: Through proper allocation of the resources to the tasks under the WBS, the associated risks, such as resource availability, can be identified. The measures that may be adopted are similar to those for schedule risk, except that the focus is on the resource itself:

   Through proper and experienced planning, critical resources can also be levelled out for efficiency.

   Historical data can establish the suitability of the type of resources allocated and the associated productivity rates.

   Logical links between tasks in which the resources are allocated help to identify the flow and availability of resources for the project.

4. **Cost risk**: The funding and cashflow can be correspondingly determined through allocation of cost to the tasks.

   Appropriate measures such as credit and loan facilities could be secured early to ensure adequate cashflow throughout the project.

   **Establishing the basis for integrated analysis of schedule & cost**

   With the establishment of the resource loaded project management plan, it is also important to establish a schedule that integrates the plan, starting with the scope of work.

   **Work Breakdown Structure (WBS)**

   The scope of work for a project is usually too large to be managed altogether and needs to be broken down into manageable components of smaller size which can be executed on the ground.

   The WBS provides such a framework and allows for consistency with the estimates, budgets and control throughout the working level.

   The level of breakdown depends on the size and complexity of the project.
WBS can be created in the following levels (refer to Figure 1):
1. Project summary where activities are summarised by project phases and key dates.
2. Contract summary where activities are summarised by contract phases.
3. Contract summary where activities are summarised by contract key dates and milestones.
4. Contract major items where activities are summarised from Level 5.
5. Contract baseline CPM network where activities are cost and resource loaded.
6. Working level programme breakdown from level 5 for site daily management.

In most commercially available network planning software, the above WBS would take the form of “aaa.bbb.ccc.ddd” where aaa is at level 1 of WBS, bbb is at level 2 and so on.

Based on the WBS, the duration of each activity involving cost can be built-up with estimates based on:
1. Historical data.
2. High-priority risk and constraints.
3. Method statements.
   a) Resources.
   b) Services and facilities.
   c) Information from market.

Cost and resource loading

Resource histograms and cashflow graphs can then be developed based on the resource and cost-loaded schedule.

This integrated and systematic approach to loading each task with the best estimates for duration, cost and resources will produce overall graphical representations that will allow management to have a clear and consistent overview of the progress of the project in-hand, as well as the effect on potential new projects.

It will assist management to identify and consider alternative project approaches such as bulk purchases across various projects, in-house fabrication and manufacturing, purchase-verses-lease, etc., in order to maximise the efficiency and profit for the organisation. It further assists management to make informed decisions for the allocation of internal funds or raising working capital through external borrowing pursuant to projected cash flow, income and expenditure.

Integrated analysis using earned value management (EVM)

The performance of a project is generally monitored through the update of actual cost and progress at regular intervals, concurrently with a review of risk. EVM in its various forms is a commonly used method of performance measurement.

The aim of EVM is to measure the project cost and schedule objectively. EVM develops and monitors three items for the project and control account.
1. Planned Value (PV) is the authorised budget assigned to the work to be accomplished for an activity or WBS component. It is allocated by phase over the life of the project.
2. Earned Value (EV) is the value of work performed for an activity or WBS component. The EV being measured must be related to the PV baseline. The term EV is often used to describe the percentage completion of a project.
3. Actual Cost (AC) is the total cost incurred and recorded in accomplishing work performed for activity or WBS component. The AC has to correspond in definition to what was budgeted in the PV and measured in EV (e.g. direct hours only, direct cost only, or all costs including indirect costs).

The three parameters for PV, EV and AC can be monitored and reported on both a periodic basis and cumulative basis (refer to Figure 2).

Project managers monitor EV incrementally to determine current status and cumulatively to determine the long-term performance trends together with the associated risk. Much of the focus of cost control involves analysing the relationship between the utilisation of the allocated budget against the actual expenditure and identifying the cause of any variance (refer to Figure 3).

Risk monitoring and control is the process of implementing risk response plans, tracking identified risks, monitoring residual risks, identifying new risks and evaluating risk process effectiveness throughout the project life cycle. Integrating both process techniques such as variance and trend analysis, which require the use of performance information generated during project execution, will help to identify the root cause of variances.

Monitoring and controlling risk also involves choosing alternative strategies, executing contingency or fallback plans, taking corrective action, and modifying the project management plan. Contingency reserves of cost or schedule time (float) should be modified in alignment with the current risk assessment when necessary. It also includes updating the organisational process assets, including project lessons learned databases and risk management templates for the benefit of future projects.

**Conclusion**

The key to the success of a project lies in the ability to understand, identify and respond to high-priority risks along the critical path of the project. The critical path can be established through appropriate WBS and logic links. Coupled with the integrated and objective analysis of the resultant schedule and cost variance, management are able to respond appropriately and effectively to risks arising.

In addition, integrated analysis allows close and structured monitoring and project control with a view to securing appropriate cash flow throughout the project life cycle.

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