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ALIGNING RISK MANAGEMENT PRACTICES IN INSURANCE WITH INSURED OPERATIONS

Girijesh Pathak[1]
Ph D Scholar, Jharkhand Rai University, Ranchi and
Faculty Member, National Insurance Academy, Pune

Dr. Ashfaque Alam[2]
Associate Professor, Jharkhand Rai University, Ranchi

Dr. Amar Nath Jha[3]
Professor and Director, BIT Off Campus, Lalpur, Ranchi

Abstract

Risk is synonymous to uncertainty and is measured in terms of probability. Risk management is all about controlling the decision variables in such a way that probabilities of different happenings move in the desired direction. Thus, not only probability values but their sensitivity towards changes in decision variables values play huge role in risk management. One of the major risks in project is related to the timely completion of the project. Project managers use various techniques to estimate time required in activities of the project and prioritize the activities to finish the project according to the schedule. Project management techniques involve preparation of work break down structure, conducting CPM/PERT analysis, preparation of Gantt chart and prioritizing the activities to keep the probability of completion of the project within planned period under control. Activity time estimation by project managers is based on the uncertainties involved in the activities as perceived by the project team. The estimated variance of an activity time in a project activity is a true measure of risks involved while conducting that activity. Similarly, the analysed variance of the project completion time measures the risks involved in conduct of the entire project. Thus, project management data can be very useful source for risk understanding in the project and thus project insurance professionals can use them for risk measurement and management for project insurance. This paper discusses about how the risk understanding of project personnel about the activities in a project can be effectively used by project insurance professionals in risk management in project insurance. Since, project managers work with various data related to activities in the project, this approach towards risk management gets driven by these data. This leads to an approach that focusses on determination of risk and managing them with proper quantification.

Keywords: *Project Insurance, Risk Management, CPM/PERT, Project Management*

Introduction:

Project comprises of a set of interrelated activities that needs to be completed maintaining their interrelationships. The project is considered to be completed if all the activities of the project are completed. There may be some activities that can be done in parallel while there may be some activities that are to be done only after completion of some other activities. Accordingly, there is some earliest start time for each of the activities in the project. These are such times before which the activities cannot be started. Each activity requires some time to finish. So, there is earliest finish time for each activity before that it cannot be finished. The earliest time by which all the activities of the project can be finished is taken as the planned project completion time. This becomes somewhat tricky that the project is planned to be completed in the earliest possible time and if not planned properly, one can expect to have a high-pressure situation all the time during the project thus increasing the risk.

Different activities in the project may require different resources and hence the resource requirement varies during the project period. Similarly, does the risk exposure. Project management team has the responsibility to complete the project in time as per the required specifications. For this, they apply various tools and techniques of project management. CPM/PERT (Critical Path Method/ Programme Evaluation and Review Technique) is one such technique that helps in identifying the critical activities and thus prioritise various activities and allocate resources accordingly. All the end activities which are not predecessor of any other activity in the project need to be completed by the planned project completion time. The highest of the earliest finish times of the end activities is the project completion time as all the activities in the project need to be completed. So, the activity having the highest earliest finish time is a critical activity which requires priority whenever it is available to be done. Other end activities have earliest finish time lesser than the project completion time, hence some delay in their completion can still be managed to avoid any delay in the project completion. This brings a concept of latest finish time for activities by which they should be completed so that the project can still be finished in time. Accordingly, each activity has latest start time as well before which it must be started to avoid any delay in project completion. The activities that have their earliest start time and latest start time same are considered to be critical activities as they need to be started and finished as early as possible. Any delay in these critical activities lead to delay in project completion. Remaining activities that have difference between latest start time and earliest start time has extra days available equal to the difference in these two times. So, a delay in this range can still be accepted without affecting the project completion.

These project management techniques provide such analytics that are highly useful for project managers in understanding the risks associated with various activities in the project and managing them. One of the most prominent measure of risk related to timely completion of project is known as variance of project completion time. This variance is based on the variance of activity times of various activities in the project. These are computed on the basis of three types of time estimates for each activity called optimistic time, most likely time and pessimistic time. The activities with high risk and uncertainty has high variance.

These data created and used by project managers contain useful information related to their understanding about the risks involved in the project. These are quite valuable for project insurers. These can be quite effectively used in finding the probability of project being completed before certain predetermined time. This is helpful in determining various risk exposures and can also be used in creating a win-win situation for the insurers and insured by using scientific underwriting techniques.

Risk Related Data from Project Managers:

A project passes through various phases such as project initiation; project planning; project execution, monitoring and control; and project closure. The data used in project planning phase can provide valuable information for underwriting risk in the project for the project insurance professionals.

The project planning phase involves preparation of WBS (Work Breakdown Structure) of the project, preparation of activities network diagram, CPM/PERT analysis and scheduling the activities as Gantt chart. Project management team members put their understanding of risks involved in various activities of the project in each of these project planning steps.

Preparation of Work Breakdown Structure involves identifying the activities in the project, their interrelationships, identifying the uncertainties involved based on the process and resources to be used, estimating the time required to do the activities and listing down any special considerations while doing the activities. This is such a step where the entire knowledge of the team related to the project is put on use.

The entire project is broken down into activities and sub activities. Whether few activities should be put together to make one bigger activity or an activity should be broken down further to smaller activities depends on the activities, their processes, resource required and their interdependencies. An activity is called immediate predecessor of another activity if the other activity can be started only after this activity gets over. All the activities that have no immediate predecessors can be started in the beginning and hence are called start activities. Similarly, all such activities that are not immediate predecessor of any other activity in the project are called end activities. There can be multiple immediate predecessors for an activity. In that case, the activity can be started only after all its immediate predecessor activities are over. If any of the immediate predecessors is not over, the activity cannot be started. So, this part of the WBS works on the granularity of the activities and considers the processes, resources and the nature of the activities to list the immediate predecessors.

WBS also involves estimation of time required to do the activities. It uses the skill level of resources, past data of similar activities by similar resources and also evaluates the level of uncertainties involved. If the process is highly automated, well stabilized and the resources are well trained with good experience in similar projects, then the uncertainty is quite low. In such cases the team is able to estimate a time requirement for doing such activities. In other cases, three different time estimates are done. They are known as optimistic time, most likely time and pessimistic time. These are based on some assumptions regarding the extent to which the uncertainties involved in the activity can affect the timely completion of the activity. Optimistic time is such time estimate in which one assumes that the risks involved in the activity doesn’t happen this time. Similarly, the pessimistic time is such estimate in which it is assumed that all the risks involved in the activity would work against during the project. The most likely time is somewhere in between the two. Scientific time estimation techniques are used in these estimates and they can be a reliable source of understanding related to the risks involved in the activities. Activity time follows Beta-distribution for which the variance is equal to the square of what one gets after dividing difference between pessimistic time and optimistic time by six. Variance of time estimates of activities with higher risk is higher than those of the lower risks. The expected time is calculated as weighted average giving 4 times weightage to most likely time and one weightage to optimistic time and pessimistic time. An activity that has long process but less uncertainty will have high expected time but low variance in activity time. There can be such activities that are short but risky. Such activities will have low expected time but high variance in activity time. Project insurers can look into the variance of activities in the project management document and focus on high variance activities during underwriting so that the associated risks as understood by the project managers are taken care in risk assessment.

The WBS is used to prepare an activity network diagram that is a pictorial representation of the WBS data. The network diagram shows the activities as per their interrelationships and various time estimates of the activity time duration. It is used to analyse the project and plan various activities. The CPM/PERT analysis on this compute the earliest start time, earliest finish time, latest start time and latest finish time of all the activities in the project. The difference between latest start/finish time and earliest start/finish time of any activity provides some idea about the permissible delay in completion of the activity without delaying the project completion. These are called float. Project managers compute three types of float like free float, independent float and total float for activities and use them depending on the need. All these floats provide permissible delay in an activity for different results. Activities with no float are considered critical activities because in those activities delay is not permissible. They are managed by giving priority in allocation of resources, focussed handling of deviations etc.

Results of these analysis are used in scheduling the activities of the project. An activity cannot be started before its earliest start time and its finish should not go beyond its latest finish time. Gantt chart is prepared which schedules the activities on time scale by factoring in the working days and working hours for the project. This is an important document for planning the resources for various activities of the project. The project activities are executed as per this schedule and the progress is monitored and controlled.

In risky projects where the uncertainties are significant, the project managers set a target probability of completion before the planned time and plan the project accordingly. Timely completion of the project is important for success of the project. Project team doesn't like to work with a plan that has 0.5 probability of completion. Keeping the probability of completion in planned time as 1 and preparing a project plan is generally not acceptable to the stakeholders as such plans are too dull to be attractive enough. Setting a target probability depends on the nature of the project and also the comfort level of the project team and the stakeholders with the probability. It helps to evaluate the sensitivity of the probability of timely completion of the project with respect to planned time.

The project completion time in uncertain situation follows Normal distribution with sum of expected time of critical activities as mean of the distribution and the sum of variance of the critical activities as variance of the distribution. The square root of variance is called standard deviation. Project planning team computes the mean and standard deviation of project completion time distribution and are able to compute the probability of timely completion of the project against a planned time. Inversely, they set the target probability and compute the planned time so that the probability of timely completion is as per the set target.

These happen in the project planning phase. Various milestones are defined in the project for monitoring and control purpose. These milestones are often related to end or start of certain set of activities. Projects are executed according to the plan. Progress of the activities are monitored according to their plan and critical nature. Reviews are done as per the milestones or as the need be. However, in spite of all the planning and care, deviations from the plan happens during the

execution. Deviations within the float available does not change the critical path. But, a change beyond that changes the critical path itself because the activities dependent on the heavily delayed activities need to be given priority to avoid further increase in delay in project completion.
Thus the project planning documents contain data related to the activities, their interdependencies, resources required, estimated optimistic time, estimated most likely time, estimated pessimistic time, computed expected activity time, computed variance of activity time, computed earliest start time, computed earliest finish time, computed latest start time, computed latest finish time, computed floats, computed expected project completion time, computed variance of project completion time, scheduled dates of various activities etc. These data are important source of risk understanding of the project team members and are likely to be important data for insurance professionals too in making major decisions related to insuring the project.

Decoding Risk from the Data:

Consider an activity 'a' whose estimated optimistic time, most likely time and the pessimistic time of completion are very close to each other but all these numbers are relatively high. It means that its expected time of completion is high but variance of activity time is low. This activity is a time taking activity as its expected time is high but it doesn't involve much risk as its variance of activity time is low. It indicates that the processes are quite stable. Heat treatment, plating etc. are examples of such process where time is required but it can be automated to such an extent that the variance in activity time gets quite low.
Consider another activity 'b' that has large difference between estimated optimistic time and pessimistic time of completion and the estimated most likely time is also close to the pessimistic time. Also, these estimates are relatively high resulting in high value of expected activity time. Since the gap between the three estimated times is high, the variance of the activity time too is high. This is such an activity that has high expected activity time with high variance. It is a time taking activity and its risky too. Since, the most likely time is closure to the pessimistic time, the exposure to associated risk will be for relatively longer duration. Such activities need to be evaluated in much detail in making insurance related decision by the project insurer.
Suppose there is an activity 'c' that has estimated optimistic time, most likely time and pessimistic time of completion close to each other and also they are relatively on the lower side. Its expected activity time and variance of activity time are small. It is an activity of small duration and also has no or low risk because of the low variance. Even if the risk happens, its exposure is for small duration. While making insurance decision, an insurance professional can at the most verify the reason of high confidence in few of such activities in the project.
There can be some activity like activity 'd' where there is huge difference between estimated optimistic time and pessimistic time of activity completion and the estimated most likely time is close to the optimistic time. These estimated values are relatively small making the expected time for the activity low. But the variance of activity time is high because of high difference between estimates of pessimistic time and optimistic time. Such activities are small activities, take less time but are quite risky. The process might not be stabilised, people might not be experienced enough, there might not be sufficient training etc. There is high risk involved, however the exposure is for short duration.
Thus, by looking at the distribution of activity time estimates, insurance professionals can identify the activities with high or low risk or duration of risk exposure. It can be used in determining the

extent of risk evaluation required in various parts of the project and align the risk underwriting process with the project management process.

Project completion time follows normal distribution with mean and standard deviation that are computed through the CPM/PERT analysis. If the activities on the critical path have high variance in activity time, the variance of the project completion time too becomes high. This makes the standard deviation of project completion time high. Higher this value, higher is the risk in the project. These computed data also provide idea about the sensitivity of probability of timely completion of the project against the planned time. By analysing this sensitivity, insurance professionals can bring the planned time to such range where the probability of timely completion becomes high and the sensitivity of this probability becomes low. However, insurance professionals don't have any control over the planned time of the project. They can utilize this knowledge in their underwriting process to decide about any excess that can be applied and impact of them on premium amount to be charged.

A project with high mean and standard deviation of project completion time is a risky project and the risk exposure is for a high duration. The premium for insurance is likely to be high that may not be easily acceptable to the project team. This data driven approach can help in creating an acceptable situation for both the parties of the insurance.

Risk Sensitivity:

One important aspect with projects are that they need to be completed within a planned time. Time overrun leads to cost overrun as well and is a major cause of project failure. Successful completion of project within time is also necessary for other business related activities that depend on this project. Since, this is a major concern for all the project stakeholders, insurance of a project against timely completion can be a major business area in project insurance.

Sensitivity of the risk that the project will not be completed within the planned time with respect to the variations in planned time is an important parameter in underwriting this risk. The expected project completion time that is a kind of mean, the standard deviation of the project completion time and the planned project time are the three variables that affect this sensitivity. Following tables show the sensitivity of the probability that the project gets completed within planned time in four different cases; one each for low project time with high variance, low project time with low variance, high project time with high variance and high project time with low variance.

Table 1: Sensitivity of probability of project completion in planned time (Mean 30 days and Standard Deviation 40 days)

Probability	Planned days		Probability	Planned days
0.3	9.023979492		0.8	63.6648493
0.35	14.58718134		0.82	66.6146035
0.4	19.86611587		0.84	69.7783153
0.45	24.97354613		0.86	73.2127736
0.5	30		0.88	76.9994717
0.55	35.02645387		0.9	81.2620626
0.6	40.13388413		0.92	86.2028624
0.65	45.41281866		0.94	92.1909438
0.7	50.97602051		0.96	100.027443
0.75	56.97959001		0.98	112.149956

Table 2: Sensitivity of probability of project completion in planned time (Mean 30 days and Standard Deviation 3 days)

Probability	Planned days		Probability	Planned days
0.3	28.42679846		0.8	32.5248637
0.35	28.8440386		0.82	32.7460953
0.4	29.23995869		0.84	32.9833736
0.45	29.62301596		0.86	33.240958
0.5	30		0.88	33.5249604
0.55	30.37698404		0.9	33.8446547
0.6	30.76004131		0.92	34.2152147
0.65	31.1559614		0.94	34.6643208
0.7	31.57320154		0.96	35.2520582
0.75	32.02346925		0.98	36.1612467

Table 3: Sensitivity of probability of project completion in planned time (Mean 270 days and Standard Deviation 200 days)

Probability	Planned days		Probability	Planned days
0.3	165.1198975		0.8	438.324247
0.35	192.9359067		0.82	453.073018
0.4	219.3305794		0.84	468.891577
0.45	244.8677306		0.86	486.063868
0.5	270		0.88	504.997358
0.55	295.1322694		0.9	526.310313
0.6	320.6694206		0.92	551.014312
0.65	347.0640933		0.94	580.954719
0.7	374.8801025		0.96	620.137214
0.75	404.89795		0.98	680.749782

Table 4: Sensitivity of probability of project completion in planned time (Mean 270 days and Standard Deviation 20 days)

Probability	Planned days		Probability	Planned days
0.3	259.5119897		0.8	286.832425
0.35	262.2935907		0.82	288.307302
0.4	264.9330579		0.84	289.889158
0.45	267.4867731		0.86	291.606387
0.5	270		0.88	293.499736
0.55	272.5132269		0.9	295.631031
0.6	275.0669421		0.92	298.101431
0.65	277.7064093		0.94	301.095472
0.7	280.4880103		0.96	305.013721
0.75	283.489795		0.98	311.074978

As per the data in Table 1 and table 2above, for a small project of expected project completion time as 30 days but high standard deviation of 40 days, the planned days of 112.15 gives a probability of completion within planned time as 0.98. If the risk is reduced in terms of standard deviation of project completion time to 3 days, the same probability of success is achieved with a planned day of 36.16 days only.

Similarly, for a big project with 270 days expected project time, the probability of completion is 0.98 for planned 680.75 days for a standard deviation of 200 days. Same probability of success is achieved with planned 311 days if the standard deviation is 20 days. Table 3 and Table 4 above shows the probability of completion in planned time for various planned days for projects with standard deviation of project time 200 days and 20 days respectively with the expected project time same as 270 days.

Sensitivity of the probability varies from project to project and also depends on planned time and the uncertainties involved within a project. Hence, use of project specific data is necessary to get a good result. Generic data may build misleading opinion about the sensitivity of probability of project being completed within planned time.

Conclusion:

This approach makes the insurer determine the risk through the project planning data and helps in making some important underwriting decisions for scientific risk management. For example, a project with expected project time as 270 days and standard deviation of project time as 20 days as given in Table 4 above can be planned for various project duration depending on the comfort level of the project team and stakeholders with uncertainty. This project planned for 287 days has a probability of 0.8 (refer Table 4 above) that it would be completed within the planned time. If it doesn't get completed in this time then it is a huge loss for those whose activities depend on completion of this project. If this project is insured for timely completion, then the probability of claim would be 0.2 because the probability of the project getting completed in planned time is 0.8 only. This may be a big risk for the insurer and they may like to take it by charging high premium. But, this data driven approach provides an insight that the probability of project getting completed before 311 days is 0.98 (refer Table 4 above). So, if an excess of 311 - 287 = 14 days is applied then the probability of claim reduces to 0.02 only. An excess value means that any excess up to this value wouldn't qualify for claim. In this case, a delay in project completion up to 14 days wouldn't qualify for claim. Claim will arise when the delay is of more than the excess i.e. 14 days. Even an excess of 7 days reduces the probability of claim to below 0.1. This can help insurer to reduce the premium, get business and keep the risk in the acceptable limits. An excess of 7 days or 14 days in project completion time of a project that has been planned to be completed in 287 days is not a difficult thing to negotiate at.

Risk is measured in terms of probability. Risk is managed by managing decision variables through various decisions that in turn affect the probability under consideration. How fast or slow the probability changes with the change in decision variables is an important consideration in risk management. This data driven approach aligns the knowledge of project managers about the risks involved in the project with the risk management practice and helps the insurers in achieving scientific risk management.

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