Technology – A Risk Prevention / Mitigation Tool

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This paper highlights the possible use of various technological advancements as a tool to prevent or mitigate risk rather than merely a tool that assist in determining disputes between parties.

This paper offers an insight an Contractor risk management tools as well as computerized work programmes with resources scheduling. This paper does not seek to suggest that the available torts are exhaustive to those mentioned but seeks to give the reader some insight into the concept as a whole with examples of such technological tools.

This paper is also a further continuation of the author's other papers on the concept of risk management namely "Risk Identification and Allocation – A Necessary Step" and "Determining the Procurement & Pricing Structure".

In Malaysia there is seemingly a lack of emphasis placed on techniques of risk analysis for the purposes of planning, fixing durations and scheduling.

Time is a matter of concern for both the developer/owner and the contractor and the feasibility of the time or duration fixed by the developer/owner or accepted by the contractor requires a constructive analysis of likely impacts, likely effects and this may then dictate the likely allocation, control, management and mitigation methods employed for time related risks.

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Statistical Sampling Technology

Early risk analysis can provide early foreseeability of the potential risk events and likely impacts thereby determining the considered approach for the contractual structure, price structure and contract conditions.

The techniques are all models using statistical sampling of variable events and likely impacts. Risk analysis using technological statistical sampling has become the most considered method of recognizing likely effects by likely causes, the chances of those causes and effects occurring and the extent to which they can be considered acceptable or they can be mitigated. This is not just a part of successful decision making on risks but it is a part of successful and efficient project management, especially for large and complex projects.

Today due to the existence of useable, functional, convenient and speedy risk analysis software, the techniques are available to many. Most of the software in the market can be used as a stand-alone application or can work as an add-on to the commonly used Microsoft Excel and Microsoft Project. Some examples of these risk analysis software which are available in the market are Primavera Monte Carlo, Pertmaster Project Risk, Intaver Risky Project, Palisade @RISK for Project, Crystall Ball, Projistic etc.

All risk analysis are essentially probabilistic models developed to translate project characteristics into risk boundaries mainly related to time. There needs to be firstly the duration for activities within the schedule or a planned duration, which is considered reasonable. There should also be a construction logic in place which effectively translates into a CPM.

Most of the software adopt the Monte Carlo Simulation, the Latin Hypercube Sampling, the Petri Net Simulation or the what-if simulation, and perform reiterations to generate outcomes by using various types of probabilistic distributions such as Triangular, Normal, Uniform, BetaPert, LogNormal and so forth to simulate the performance of a project. Essentially, the power of these simulations and reiterations lies in the picture of possible outcomes it creates. Simply by inputting the uncertainties, choosing the best suited distribution and running a simulation, these advanced risk analysis tools take the project model from representing just one possible outcome to representing thousands.

The variable or risk events must be identified from literature, domain experts or experience. The effects of these risk events are also then to be gathered from the same source. Then a probability is derived for each simulated risk events to effects and finally the model is verified or validated. There are numerous literature to gather risk events and likely outcomes. Some of them are referred to in the attachment at Addendum 5

The use of these type of software is exceptionally useful for contractors to work out their planning, their schedules, their effective CPMs and their floats. It also allows simulations of mitigation plans or corrective plans in order to recover likely effects and the contractor can prepare and employ a particular mitigation plan that show the best recovery based on the probabilities of effects.

Using such techniques becomes an effective employment of a good risk management system during the planning and scheduling stage and also during construction stage which ultimately enables the project team to confidently manage the project by allowing introduction of corrective measures, monetary contingency and scheduled float in order to minimize losses to the project and maximize the likelihood of the project finishing on time and within budget.

With these software, uncertainties or risks in time, resources and costs can be conveniently input and modeled for a project using various types of distribution probabilities and perform simulation to produce a more realistic project by evaluating and calculating the chances that the project will be completed on time and within budget, and present results in straightforward answers and easy-to-understand formats.

With this wealth of extra information, the following questions can now be confidently answered with ease based on the statistical probability of events rather than just having to rely on one's experience and his gut feeling; What is the probability of finishing the project on time and within budget? What are the chances of finishing the project by this day? Which tasks have the most amount of risk and are most likely to cause project delay and need to be mitigated first? How much is the project most likely to cost after incorporating the risk mitigation measures?

In addition, the risk analysis application is able to monitor the progress of construction by assessing the need to refine the initial strategy or to change courses when a new risk is discovered or as resource availability changes during the construction phases. This effectively helps to reduce the chances of being late and over budget as the project is progressing mid-way. Basically by making any what-if changes to an on-going project, an immediate result on how the change impacts the project can be observed within seconds and subsequently decision making can then take place without much further delay and with confidence.

One does not need to be a statistical expert or have any prior knowledge of risk analysis theories to be able to perform a thorough risk analysis for a project by using the software available. They are used by project team members of all levels, from young engineers just entering the project risk management arena to the world's leading construction risk experts.

With such technology in risk management, one can conveniently peruse other parties' work programmes produced from project management software, such as Primavera Project Planner, SureTrak, FastTrack Schedule and Microsoft Project, to perform your own risk analysis for a similar project. This can simply be done by importing the work programme electronically into the risk analysis application, identify and allocate the uncertainties or risks for each task, proceed with the step-by-step instructions, and in no time, a risk analysis for the project would have been performed. This risk management procedure is very useful for owners and consultants to manage the contractors effectively so as to avoid unnecessary work disruption and claims.

Besides, technology allows project team members to contribute to the risk database with their own uncertainties or risks they foresee in the project, identify the severity of the risks, analyze the impacts, and discuss ways to mitigate the risks in a more effective and cooperative fashion as a team. Over time, risk management allows the project team to build a more comprehensive risk database based upon their experiences and lessons learned, which will be useful for better management of future projects.

Results generated from risk analysis are clearly presented in preformatted professional and easy-to-interpret templates (table, schedule, summary etc.) and charts (Gantt Chart, S-curve graph, histogram, etc) bundled in these software. Therefore, reporting is made easy to pinpoint and convey the risk impacts and mitigation recommendations to the management effectively. Some examples of the charts are attached as Addendum 6.

The tool is also considered useful for developer/owners in assisting them to assess likely risk impacts and likely success of mitigation or recovery plans for the contractors. It also serves as a management tool for likely impacts caused by developer/owner responsibilities such as design information delays or interruptions in a fast track project at parameters of the low and high levels, thus understanding the

exposure, and the situations where the developer/owner must insist that no delays are forthcoming from the consultants.

Obviously, the tool requires development from the contractor's angle as well as the developer/owner's angle. There are situations where in addition to the work programme and the critical path network, the contractor may be asked to produce these statistical sampling tools as a gauge for the management of the contractor's biggest fears therefore alerting the developer/owner as to the areas where the contractor feels will be his Achilles heel and the developer/owner can take steps to ensure that this does not occur or is mitigated if it is within the developer/owner's control or managed if it is within the contractor's control.

The mentioned technological tools are also being used by contractors to determine likely risk events that may cause an overrun of their budgeted cost as well as the likely risk events that could bring on LADs thereby further impacting the project cashflow. All of these types of analysis will therefore show the likely risk events that will affect the profit margin hoped for. So risk on cost can likewise be simulated. It is unlikely however that this analysis will be shared with the developer/owner pre-contract.

Computerised Work Programmes

Today, technology has drastically changed the face of time management. Therefore knowing the existence of these technological tools allows the developer/owner to better decide the allocation of risks on time issues.

Network programmes are the common tool used in today's project because it identifies in detail not only the activities and the durations planned by the contractor but also their interdependence on each other. The network programmes represents the

time characteristics of the project and not just each individual activity. The additional project dimensions mean that it is necessary to consider the introduction of additional activities which do not represent tasks, but contingencies in time for risk events or "time risk allowances".

The most commonly used network programme is the critical path programme which models the construction logic links between each activity in detail. The construction logic is then represented in the defined construction sequence of the project and it sets out explicit details of minor and major activities relating to the method of work, the sequence within each method of work, the construction constraints which include dates when areas of work must be made available or dates when information should be already with the contractor and it further provides the resource restraint which shows the availability of plant, equipment, labour and the need for materials modeled within the sequential linking of activities using the same resource.

There are two types of critical path programmes, one being the Activity-on-Arrow programmes and the other being the Activity-on-Node programmes.

The importance of having such a detailed work programme with this type of critical path network is that it will indicate the logic used by the contractor, the floats that exist within non-critical activities and eventually become the tool to analyse whether a delay to an activity has truly impacted the contractor's ability to complete the entire works within the completion period.

Furthermore, linking the detail programme to resource allocation and usage allows an assessment of whether there has been a reasonable assessment of resources required by the contractor for particular activities therefore avoiding allegations of disruptions and lost of productivity or delay simply because the contractor did not allocate sufficient resources in the 1st place to the particular activity.

The link to resources also provides a tool for effective resource leveling and resource reallocation along with re-scheduling the works when delay event occur so as to mitigate the time and cost impact.

The logic links ought to show a finish-to-start link, a finish-to-finish link, a start-to-start link and in some instances although rarely a start-to-finish link. It is in recognizing that no activity is truly indivisible and complex works usually consist of a considerable number of separate task and activities all of which normally do have some form of interrelationship and interdependence, that the need for this particular type of work programme will be clearly required.

All these information cannot be satisfactorily produced manually. However, in today's technology there are softwares that provide a contractor the ability to reflect his planned works in such detail with his resource planning as well. All this information can only benefit the developer/owner as it allows the developer/owner to equally manage the time and resource of the contractor and to be aware of developer/owner's activities that interact with the contractor's activities.

It also becomes a tool that ensures the truth is revealed and allows decisions to be made on liability for time and cost without having to resort to legal dispute resolution processes.

Having such a requirement within the contract structure may require an element of pricing within the preliminaries in the contract and there will be a cost impact on both parties relating to maintaining the appropriate personnel who understand and are able to manage such programmes. However, the benefit from having this programmes can be considerable as seem later in the discussions on the topic of handling time and cost risk.

One of the leading work programmes that offers both time and resource linking is the Primavera Project Planner (P3). The P3 programme provides managers and schedulers total control over the time and resource based performance within the contract. It is effectively a management tool for both developers/owners and contractor and its designed to handle high intensity, short duration, time critical, large scale, intricate and multifaceted projects. It can handle thousands of activities within one project.

The other very important benefit of such a programme is that it allows both parties to analyse unlimited "what-if" alternatives and target plans. It allows the addition of variation task, evaluates floats, and provides visual appreciation of impact and on-going activities in an organised and colour coded presentation.

It also provides resource scheduling with advance resource leveling options.

Most importantly it is a live programme which can be imputed on a daily basis thereby allowing an appreciation of the evolvement of the progress of the project and the progress of each individual activity with impacts on float and float tracking appreciations on an immediate basis. It allows also appreciation of precedence relationships and cascading effects of project bottlenecks.

Further by using fragnets it allows particular groups of task and resource allocations to be extracted individually so that a programme within a programme can be created to analyse events in more detail.

In analyzing delay impacts the software work programme allows the ability to crunch information and rebuild an as-built live programme retrospectively or if the analysis is being carried out immediately after the delay event it allows resource rescheduling and activity rescheduling with leveling options so that a party can analyse various

different alternatives to mitigating a delay event and its impact so that time and cost overall is reduced.

Without this tool time and cost management for delay events can never effectively take place through the developer/owner and the developer/owner is at all time as the mercy of a willing or reluctant contractor. A sample of some of the charts and presentations of Primavera is in Addendum 7.

It is noted that the JKR standard forms of Conditions of Contract makes no mention of a work programme let alone a computerized work programme as mentioned above.

It is possible that the intention was for the standard to be stipulated in the specification but the danger with the work programme being referred to in the specification is as to whether it truly becomes a document (hard or soft copy) within the Contract and hence binding on the parties and whether it becomes an effective tool applicable and binding in determining issues such as EOT, mitigation and loss and expense claims.

We note that the EOT provisions in the JKR standard forms does not relate the analysis done by the SO or any other person named to the utilization of the work programme as the strict determining tool for entitlements.

This issue of whether a work programme should become the definitive tool to assess time and cost impact have previously been an issue of serious concerns by many developer/owner simply because they believe the work programme is a contractor's tool and it can be manipulated by the contractor to serve his own interest without the owner being able to assess matters appropriately.

As such, developer/owners preferred to leave the option open as to how and what tool is to be used to determine EOT.

In fact, the lack of any defined tool left the developer/owner more vulnerable by virtue of the fact that it is the contractor who has all the information as to his works and his planned progress and the contractor could develop evidence supporting his case without any real opportunity for the developer/owner to counter such as an assertion of delay and its impact.

It seems that it would be foolish for a developer/owner not to require all information in detail on contractor's plans to be provided at an early stage of the project when it is likely to be reflective of the true intentions of the contractor so that it may be utilized against the contractor at the later stage.

Furthermore, if a developer/owner takes the effort to ensure that he equally has the right personnel to analyse such a detail work programme at an early stage of the project and to input the programme based on actual events to ensure that the programme is a live programme, the developer/owner will clearly be aware of whether the contractor has produced a work programme that carries logic and therefore realistic and likewise whether claimed events and impacts are accurate.

As such, it will be required that a detailed contract clause is introduced to require a contractor to produce such a work programme at the early stage of the project for the developer/owner or its consultants verification and approval (checking the logic and whether there are artificial restraints) before such a programme is deemed accepted and hence applicable within the contract.

A contractor on the other hand should not be concerned about this requirement especially for projects of a high value (ie. anything around RM50 million) because it also allows the contractor to manage his cost and time effectively and allows the contractor to prove his entitlements to claims conclusively thereby avoiding the need

to be concerned about failing to recover compensation for what the contractor rightfully is entitled to.

A clause that can be used is as follows:-

"Programme of Works

(a) Within twenty-eight (28) days of the date of the Letter of Award, the Contractor shall submit in a form acceptable to the S.O. the following documents:

(i) a programme for the manufacture, delivery, supply, construction, installation, testing and completion of the Works, prepared using recognized computer-aided techniques and showing at least the following information:

(aa) periods for construction of each section or part of the Works;
(bb) durations of each activity in each section or part;
(cc) critical activities and critical path;
(dd) float times for each activity and total float time
(ee) latest dates for receipt of information, instructions, approvals and the like from the S.O.

(ii) ***a method statement for execution of the Works.***
No work is to commence on Site until these requirements have been filled.

(b) The Contractor shall submit to the S.O. in the form and within the periods specified by the S.O. such documents as to the planning, programming, method of execution of the Works, cashflow and

labour and materials forecasts and other documents and information of a similar nature as may be specified in the Contract.

(c) ***The programme shall be regularly monitored by the Contractor and shall be revised and updated to take into account any extension of time for completion, in accordance with the provisions of Clause 44. Also, if required by the S.O. the Contractor shall revise the programme to include any acceleration measures necessary under Clause 43 or instructed b the S.O. pursuant to sub-clause 44(f)"***

The appropriate software programme as a contracted tool in project management for both the contractor and the developer/owner would allow great advantages for both parties. It becomes the effective tool for planning relevant to both parties (ie. contractor planned sequence and commencement of various elements of work, floats and the use of floats, delay mitigation by re-sequencing, resources allocation and verification, resource leveling and re-allocation, proper assessments of EOT and productivity effects, dispute resolution tool).

The weakness in the JKR form of contract is that it does not address the provision and quality of the work programme and its resource allocations and hence does not make it a tool for time management and EOT. In such situations, the benefit can only be seen in the contractor's favour.