

TRManager – Technical Risk Manager

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ABSTRACT

This paper presents research into the development of a new information management technique called Technical Risk Manager. Project management involves the use of processes and information management techniques to aid decision making in the pursuit of project success. Project success may be achieved by meeting time, cost or performance criteria. Current project management practices focus on achieving time and cost project success criteria by using three information management techniques developed in the 1950s: Gantt, PERT and Critical Path Method. Technical Risk Manager has been developed to provide an information management technique that may be used to aid project management decision making in the pursuit of achieving the performance project success criteria.

Keywords: Technical Risk, Project Management, Management Information Systems, Engineering Management, Informatics

1. INTRODUCTION

Project managers apply Project Management (PM) principles and processes as a basis for how a project will be carried out. Project success is often measured using time, cost and performance criteria.

Throughout the project life cycle, the project manager actively seeks information to gauge progress and to permit decision making. In particular, the project manager seeks information about those areas of the project that are viewed as critically important to project success, and which, if carried out incorrectly, will result in project failure. The project manager will utilise Information Management Systems (IMS) to manage the project information.

Technical risk (TR) may be defined as “the risk that a system will not reach its performance goals, development will not be within the specified timeframe and / or it will cost more than estimated due to technical developmental and maturity risks” [1]. Technical Risk Management (TRM) is the act of planning and executing systematic identification and assessment of technical risks, and implementing means to avoid or mitigate the effects of risks if they reach an unacceptable level.

This paper provides results of research into managing technical risk information. A new information management technique called Technical Risk Manager (TRManager) is presented.

A survey carried out at the PMOz 2005 conference [2] highlighted deficiencies and issues associated with existing IMS utilised by project managers. The survey results indicate that project managers are confronted by inadequate knowledge of TR and a lack of integrated IMS with which to implement TRM. These issues appear to be related: the lack of TRM capable integrated IMS suitable for all project managers may also point to a reason why project managers have poor knowledge of TRM concepts and application.

Black [3] reports that “Increasingly, Government customers and Industry contractors seek better methods to identify and manage technical, schedule and cost risk.” The survey conducted by Black of participants at an Aerospace conference in 1998 found that 39 per cent of respondents expect engineers to play the major role in risk management, whereas 33 per cent place that responsibility on the cost estimators, and 14 per cent elsewhere. Black’s survey results highlight the variability of risk management approaches being utilised and the lack of a consistent approach due to unsatisfactory existing methods and IMS.

This paper presents a research outcome that highlights the compatibility between TRManager, Gantt, PERT and CPM. By adding TRManager to existing IMS that already incorporate Gantt, PERT and CPM, project managers will be able to carry out time, cost and performance management using an integrated IMS.

2. SURVEY

The survey was conducted during a session of the PMOz 2005 conference [2], held in Brisbane between 30 August and 1 September 2005. The annual PMOz conference regularly attracts several hundred project managers as attendees and PMOz 2005 was no exception. During the chosen session a total of 40 surveys were given out, one to every person in the session. Twenty two surveys were completed and returned, giving a response rate of 55 per cent. The purpose of the survey was to obtain a ‘snapshot’ of active project managers’ knowledge of TR and TRM tools.

Survey questions

The survey questions were designed to establish the project managers’ backgrounds, education levels, corporate knowledge and perception of their organisations’ spending on PM activities, including PM IMS.

The six areas identified in the survey were:

1. Corporate information
2. General PM information
3. Personal information
4. PM tools
5. Life Cycle Costing (LCC)
6. Activity Based Costing (ABC)

The survey was designed to provide evidence of the project manager's TR knowledge and knowledge of TR related analysis techniques and associated methods. Survey questions relating to TR aimed to identify more than a cursory understanding of what TR is and how one would go about TRM.

The survey design was to enquire about two specific analysis techniques that can be used by a project manager whilst carrying out PM and TRM. The two specialist activities (ABC and LCC) were selected because in 2003, Emblemstvag [4] developed an approach called Activity Based Life Cycle Costing (ABLCC) that is a synthesis of ABC and LCC. Information gathered for a LCC analysis is also used when carrying out TRM. LCC models have been enhanced by adding technical parameters to the project system elements thus providing whole of life costing and TRM using an integrated model.

The integration of ABC and LCC by Emblemstvag made ABC and LCC very suitable choices as the specialist activities to be included within the survey. ABC and LCC are both independently well established and broad analysis techniques that are used in many organisations today.

Life Cycle Costing and Activity Based Costing

LCC is a method which provides an understanding of the whole of life cost of a project system. When additional technical information associated with the project system elements are added, LCC models can be used to analyse the technical performance of a project system. Cost Analysis Strategy Assessment (CASA) [5] developed by the US Department of Defence is one example of a model that incorporates LCC and TRM capability.

LCC was originally developed in the early 1960s by the US Department of Defence to increase the effectiveness of government procurement [6]. LCC is a process used to determine the sum of all costs associated with a product or service over the life-time of the product or service and may be considered a technical and economic assessment process [4].

In the 1970s and 1980s, LCC was further developed and extended to include whole of life costs associated with the design, manufacture and use of the system being studied. Today LCC models have been adopted by many countries, including Australia, as a requirement for medium and large procurements within Government Departments and Organisations. Many industries are also adopting LCC as a mandatory activity to be conducted on all new projects.

ABC is an accounting method identified by Cooper [7][8] and Cooper and Kaplan [9] in the 1980s, initially at the Harvard Business School, which allows businesses to identify operating costs by analysing activities. Costs are assigned to specific activities, such as planning, R&D, implementation or in-service support, and the activities are then associated with different products or services. The ABC method enables a business to analyse activities and identify where profit or loss is occurring.

ABC techniques were initially adopted by some of the business mass media, consultants and business schools as a means of enhancing organisational efficiency, and addressing the limitations and pitfalls of traditional management accounting. Today ABC is current, well defined and used within many organisations.

Survey response

The survey respondents were active in 10 of the 17 Industry areas identified in the survey. The largest group of respondents were employed in Government Administration and Defence (28 per cent); the second largest group in Construction (18 per cent); followed by Electricity, Gas and Water Supply (13 per cent).

Thirty per cent of the respondents indicated that their organisation possessed a written company PM guideline. Those that indicated that there was a guideline provided details of the wide range of competing standards, methodologies and approaches in the PM arena.

Twenty-two per cent of respondents indicated that their organisation used an in house methodology and 22 per cent indicated that their organisation adopted all of the approaches provided in the survey question. Some of the methodologies identified were Prince2 [10], PMI IT Management Methodology, Defence Procurement Management Methodology and PMBOK [11].

The survey respondent's academic qualifications were reasonably spread with the largest groups having a Bachelors degree (27 per cent), a Masters degree by coursework (22 per cent) and either a Diploma or a Graduate Diploma (27 per cent). One of the respondents had no formal qualification. None of the survey respondents possessed a Masters Degree by research or a PhD. Overall the survey respondents' academic qualifications indicated a group of people who had carried out academic programs where they may have been introduced to PM concepts and specialist activities such as LCC and ABC, though the specifics of the academic program was not sought.

Half of the survey respondents indicated they possess a PM qualification from a professional body. Roughly equal numbers had either a Project Management Professional or a Registered Project Manager qualification.

About 88 per cent of the survey respondents indicated that their organisation used Microsoft Office® Project (MSProject) [12] as their PM tool. This response highlights the current market penetration achieved by MSProject.

Respondents indicated they use a range of software applications for specialised activities, highlighting the number of such applications on the market. 40 per cent of the respondents use MSProject in combination with other software applications to carry out cost, time and performance management.

Respondents reported that the major weaknesses of the project management tools and TR software applications that they used in their organisations were importing and exporting data, communicating with other tools, permitting team members to communicate information and compatibility. About 45 per cent indicated that communication between tools was a major

weakness; approximately 40 per cent thought communicating information between team members was a major weakness, and about 30 per cent indicated that compatibility of applications was a major weakness.

About 30 per cent of the respondents indicated that importing data was a major weakness with the tools and software applications being used. TRM methods, including LCC, use system models that are built with component information often provided by vendors and the survey highlights the problem of importing data into the software applications being used by the respondents' organisations.

More than 50 per cent of the respondents indicated that they could not import task and resource information from a data source into the software application being used for TRM. Seventy-seven per cent of respondents indicated that their PM planning tool would not permit them to import task and resource information from a data source or library.

About two thirds of the respondents indicated knowledge of LCC and ABC, although when asked to write a definition of the terms, the descriptions were vague or inadequate in 40 per cent of responses. About 30 per cent of the responses adequately described LCC and ABC.

Less than one third of the respondents indicated that LCC and ABC had been used in their organisations. The major reason cited for not using LCC and ABC was that someone, typically identified as an engineer, needed to be trained. This response points to an ongoing perception that LCC is a specialist activity to be completed by someone other than the project manager (e.g. an engineer) or not at all. This outcome of the survey correlates strongly with the survey conducted by Black [3]. Combined with the weaknesses identified in available software tools, the survey highlights two impediments preventing project managers from carrying out TRM. The first impediment is training in TR methods, such as LCC. The second impediment is access to TRM capable integrated software applications that can be used to carry out this specialist activity as an integral part of the PM processes. The benefit of removing these impediments would be to empower project managers with the capability to carry out TRM as a standard activity in the same way that project managers carry out scheduling, planning and critical management of project time and cost.

3. FOCUS ON THE PROJECT MANAGER

Let us consider the second impediment, the lack of TRM capable integrated IMS. The outcome of the research to solve the second impediment is the proposal that PM must incorporate TRM more directly and therefore PM IMS should have TRM incorporated.

Generally project managers become familiar with PM IMS and are trained in their use while completing undergraduate or PM qualifications, or through experience gained as a member of a project team. PM IMS are fundamental to the profession and used by the majority of project managers because they permit project scheduling and are inherently useful for measuring time and cost over the project life-time. Important capabilities provided by a PM IMS are the Gantt Chart, Program Evaluation and Review (PERT) and Critical Path Method (CPM). PERT was developed by the U.S. Navy in cooperation with Booz-

Allen Hamilton and the Lockheed Corporation for the Polaris submarine project in 1958. CPM was developed by DuPont, Inc., about the same time. The Gantt chart was developed around 1917 by Henry L. Gantt, a pioneer in the field of management studies.

The PM IMS is in essence a delivery platform for Gantt, PERT and CPM, each developed separately, yet each integrated into modern PM software applications. This can be done because Gantt, PERT and CPM all use four common core data elements: *time, cost, tasks and resources*.

This research presents an approach to solving the second impediment by adding TRM methods to currently available PM IMS. This approach would provide new capabilities to existing PM IMS. Earlier research [13] has shown that this is possible, because a LCC and TR method such as CASA uses the same four core data elements used by Gantt, PERT and CPM with some variations on how the information type is identified.

For a specialist TR engineer, risk is often represented in terms of complex information. As Jarrett [14] explains, however, the corporate executive is the decision maker who ultimately deals with risk decisions, and "even if it were possible to develop complex representations of risk accurately, it is difficult for the executive to deal with them. Instead, the executive is able to deal with a few scenarios and possible cases, and only with three general levels of conceptual risk associated with them: High Risk, Medium Risk, and Low Risk."

Jarrett makes an important point that supports the proposal presented in this research that new capabilities added to a PM IMS should present outcomes in a way that matches the level of understanding of project managers and executives rather than specialist engineers. This would provide a satisfactory solution to the second impediment currently preventing project managers from carrying out TRM.

The solution to the first impediment preventing project managers from carrying out TRM, that is, lack of training in TR methods, becomes immediately solvable with the development of a TRM capable PM IMS. This new PM IMS can be used in PM training courses as a logical extension to training in how to use Gantt, PERT and CPM.

Identification of the impediments preventing project managers from carrying out TRM has led to a prototype of TRManager being incorporated into an existing PM IMS. A LCC and TR add-in to MSProject was created and this capability has been used for two years in a postgraduate engineering course at RMIT University [15][16]. Feedback from the course participants indicated that more than 80 per cent of the participants found they were able to improve their understanding of LCC and TR and how to carry out TRM.

4. TRMANAGER

Data Elements

Modern IMS that implement Gantt, PERT and CPM utilise four core data elements: *time, cost, tasks and resources*.

Parameters may be associated with the core data elements to provide more information about the purpose of an individual core data element. Relationships are created between the four

core data elements to build an understanding of what is occurring as time progresses. For example, a *task* may be carried out by *resources* (people) utilising *resources* (material).

An example of the application of parameters to the core data elements is the use of qualifiers for the type of a *resource* data element. MOP [12] identifies three types of *resource* data elements: *work*, *material* and *cost*. MOP versions prior to 2007 only identified resource data elements as being either *work* or *material*. The use of parameters to qualify the four core data elements and to enhance the core data element applicability to model calculations permits IMS to adapt as new techniques and models are implemented.

The number of parameters associated with the four core data elements is related to the techniques and models being employed within an IMS. The parameters may be considered to be at a second level in the information hierarchy. Parameters are only identified as information associated with a data element.

The research identified that when TRManager was incorporated into an IMS the information hierarchy dimensions increased. The number of dimensions in the information hierarchy was found to be dependent on the model being used within TRManager. For example, when CASA was selected as the model to be used within TRManager the information hierarchy increased by two levels.

The research found that at the top level the four core data elements are sufficient to implement LCC and TR models or techniques within TRManager. This is a key finding that permits TRManager to integrate into existing PM IMS.

The principal change occurs at the second level in the information hierarchy. To integrate LCC and TR models or techniques into TRManager and to integrate with an existing PM IMS it is necessary to include a *system resource* type. For example, when the prototype TRManager was added to MSPProject the *resource* type list was enlarged to include a *system* type. This meant that the *resource* type list became *work*, *material*, *cost* and *system*.

The new *system resource* data element may now have parameters associated with it depending on the LCC and TR model being used. A system resource data element that is being used in the CASA model includes about 20 level three information hierarchy parameters. One of the CASA level three *system resource* parameters is *Reliability Growth*. *Reliability Growth* types include as level four parameters *None*, *Annual*, *Duane* and *Item*.

Models

Research into TRM identified that industry specific TRM models have been developed. The TRM models may be based on TR or integrated with LCC models. The calculations and outcomes presented by the models are tailored to the industry application.

The US Department of Defence has implemented several hybrid LCC and TR models, examples of which are CASA and Automated Cost Estimating Integrated Tools (ACEIT) [17].

The EIO-LCA model [18] considers the environmental impact of a project system and permits environmental life cycle analysis. The example data set provided with the model includes analysis of the environmental impact of automobile and light truck manufacturing.

TRManager provides an environment where one or more TRM models may be integrated within an IMS. TRManager includes a list of selectable models permitting models to be added or removed from the list. This feature of TRManager permits industry specific models to be made available within a PM IMS. A project manager working within the packaging industry would be interested in seeing TRM models being provided within TRManager that are applicable to environmental impact and life cycle assessment.

Initial research found there are now more than 50 different TRM models used regularly within industry. TRManager may incorporate one or all of the models. Each model may necessitate different level three and four information hierarchy parameters. Whilst this may be straight forward to implement using modern computing systems it is not practical to include models if the users of the system are not likely to ever use the models. Therefore, a PM IMS that incorporated TRManager should include an installation step that would let the user select which TRM models to install.

TRManager Diagram

The TRManager diagram may be altered to reflect the IMS that it is incorporated into. The information that the TRManager diagram would provide includes the *system*, *resources* and *tasks*. Therefore within the TRManager diagram the *resource system* type data elements would be presented independently of the other *resource* types.

The research identified that many of the TRM models aggregated resources and tasks into activities. An example activity could be *Transport* which combines one or more individual tasks or resources. Another example of an activity is *System Deployment*, which may include one or more tasks associated with deploying the project system.

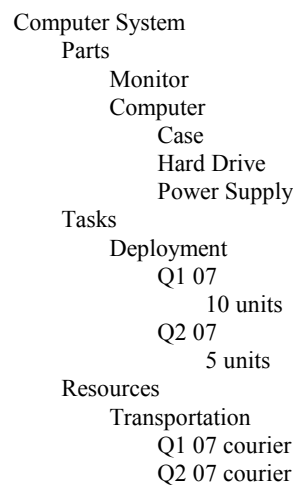


Fig. 1 TRManager Diagram System and Activity View

TRManager would facilitate information display that is system and activity based, Fig. 1, or timeline based, Fig. 2. Fig. 1

shows *system resource* data elements that make up the computer system parts. The *system resource* data elements may be hierarchical as would be anticipated in a system. In Fig. 1 the computer *system resource* data element consists of three child components: case, hard drive and power supply.

When the information is displayed using a timeline the diagram may be similar to a Gantt Chart or Network Diagram [12] with modification to display the *system resource* data elements associated with a particular *task* when a pointer is moved over the *task*. In Fig. 2, each task has an active location identified by the black triangle which would be used as a point where if the pointer was moved over the triangle the *system resource* data elements associated with the task would be displayed.

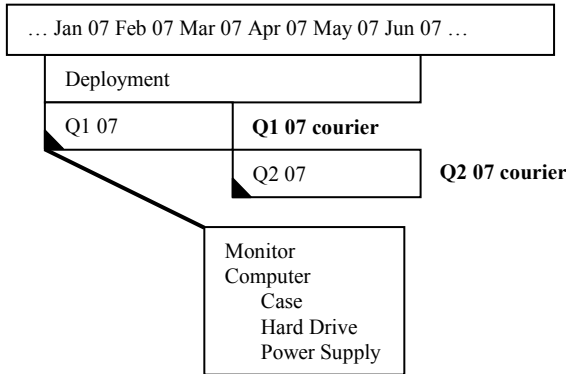


Fig 2 TRManager Diagram Timeline View

TRManager Simplification

TRManager would utilise colours or dotted lines around tasks or resources to reflect that there was an action or outcome that needed attention associated with that data element. For example, if the TRM model active in TRManager included calculation of operational availability and the calculated value had fallen below the system or sub-system target value then the data elements may be identified by a different colour to the other data elements or by a dotted line around the data elements. The research identified that the use of the stop light colours (red, yellow and green) were an effective way to highlight to project managers the current status of key project success measures.

The research found that *system resource* data elements and associated parameters may be stored in a repository and made available for use in the PM IMS through a library capability. Vendors may provide this information as a requirement when delivering a system or service.

In some situations, the *system resource* data element may contain default values for the associated parameters when first added into the project system under study. The use of colours or dotted lines would permit a visual alert to be provided to the user to indicate that one or more of the *system resource* data element parameters may need to be changed. TRManager would simplify this process by initiating a link between the visual alert and the location of the parameter field that needs a new or different value. This link may be activated by the user "double clicking" on the *system resource* data element.

TRManager Reports

The TRM models presented through TRManager would include calculations and reports. The research identified that the reports would be selectable through the IMS reports list. The IMS may have reports associated with the Gantt, PERT and CPM techniques and other reports associated with features that have been added to the IMS.

The IMS reports list would be dynamic so that it would include the currently active TRM model in TRManager. If the active TRM model or technique was changed then reports in the IMS reports list would change to reflect the reports offered by the currently selected TRM model or technique.

5. CONCLUSION

This paper has presented a new information management technique called TRManager. TRManager integrates with and complements the existing project management techniques, Gantt, PERT and CPM. The benefit of TRManager is to provide an integrated environment where project managers can carry out time, cost and performance management.

The research was supported by the results of a survey of project managers. The survey was designed to examine the participants' understanding of PM planning tools, access to TRM capable integrated software tools, and their understanding of two specialist activities, one of which is TRM related and the other cost related. The survey results showed a correlation with earlier research by Black [3] and Jarrett [14]. The research has identified two impediments to project managers carrying out TRM directly and proposed a solution to the two impediments. The research proposes the use of a PM planning tool as the delivery platform for TRM and argues that this is a fundamental logical extension of the inclusion of Gantt, PERT and CPM within PM planning tools. The new PM and TRM integrated tools can be used initially as part of the future project manager's education and then throughout the project managers career. Feedback from University course participants who have used a PM planning tool that has had LCC functionality added indicated that 80 per cent of students found using LCC within the PM planning tool made the process of learning about TR methods and TRM easier. Project managers with a better understanding of technical risk will have acquired important knowledge that will enhance their ability to ensure project success.

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