and Associates Limited

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Project Management and Construction Claims Services

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THE VIABILITY OF A CONSTRUCTION PROJECT CAN BE MEASURED AND MONITORED. REVAY AND ASSOCIATES LIMITED IS PLEASED TO ANNOUNCE STABILITY INDEX PROJECT EVALUATION SERVICES.

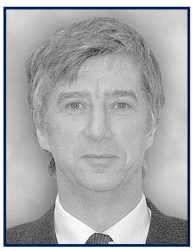
As a consequence of our claims related services, Revay and Associates Limited has extensive and unique knowledge of the factors leading to project failure. Two of our senior consultants, Peter Maidment and Martin Gough, have combined their project management experience with this claims related root cause awareness to develop a model for the capacity of the project team to manage risk.

From this model, the Project Stability Index has been developed to assess the capability of the project delivery systems and of the project team to manage risk events. The following article describes the model and its application.

Revay is currently partnering with several major clients on initial project applications of the Stability Index to validate and field test the method and subsequent results.

In offering this service to our clients we will be applying our unique knowledge sufficiently early for the project team to recognize changes that will significantly improve the probability that the project will meet its planned goals.

THE STABILITY MODEL METHOD OF RISK MANAGEMENT AND EARLY PREDICTION OF PROJECT PERFORMANCE



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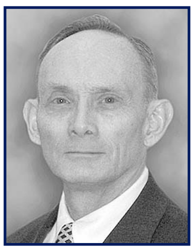

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The underlying basis of the Stability Model is that projects frequently fail to fully satisfy their objectives due to the effect of numerous minor risks that cascade into serious impacts, rather than necessarily from major risk events. The "stability" of a project is defined as the ability of the project to resist this effect.

1. SUMMARY

The Project Stability Model is a comprehensive methodology for quantitatively and objectively evaluating the probability of project success. It evaluates inherent project risks, the integrity of the Project Delivery System and the effectiveness of the project team.

Once the Project Stability has been evaluated, prioritized remedial actions can be taken to improve the Project Stability score and thereby the probability of a successful project. This process can also be used to evaluate and compare projects during project selection and portfolio management.

The application of the Project Stability Model is of particular relevance to owner organizations that have taken the strategic decision to become more involved in the planning, monitoring and management of their projects rather than relying on the management processes, procedures and competencies of their contractors or consultants.

The Project Stability Model also illustrates the necessity of applying proper project delivery practices at all levels throughout the project. By employing the same Project Delivery System practices to manage the work throughout all levels of the project work breakdown structure as those for the overall project (i.e., applying the concept of "self similarity" at all levels of management of the project), minor project risks are prevented from coalescing into ever more serious risks.

2. INTRODUCTION

Traditionally, the approach to project risk management has been centered on identifying and characterizing the various risks involved in implementing the project, assessing their probability and impact on the project and then developing mitigating plans, which are monitored for their effectiveness upon implementation. Typically, the focus of this process has been the more critical project risks. The minor and lower severity risks are often ignored.

This approach to risk management is limited. In many actual cases, it is not the serious major risk events that are the root cause of a project's major cost and schedule overruns. This is because the types of risks considered critical are, in most cases, identified and effectively mitigated by the project management team. This observation is supported by the authors' extensive experience in construction project claims, which has included the detailed assessments of the root causes of many project cost and schedule overruns.

Project failure is frequently caused by the precipitation of many minor risks.

Major cost and schedule overruns (as well as other major variances in planned project outcomes) are typically caused by the advent of a large number of what would normally be considered individually as minor risks. These risks amalgamate and cause a cascade effect precipitating risks of increasing severity. It is only when the resultant risk manifests itself at a high level that it is finally recognized by the project management team. Some typical examples of these precipitated risks encountered on construction projects include:

- Delays in obtaining regulatory approvals, land right-of-way and other external approvals.
- Delays in obtaining internal project approvals.
- Late design changes by the owner.
- Checking of design drawings.
- Design errors and omissions.
- Lack of proper design integration by the engineering disciplines.
- Errors and omissions in the owner's requirements.
- Delays in issuing contracts and purchase orders.
- Incomplete scope and quality definitions in contract documents.
- Deficiencies in vendor materials and equipment.
- Deficiencies in the project management controls processes.
- The evaluation and processing of Change Order requests.
- Collection, amalgamation and reporting of contractor progress data.

- Late delivery of Issued For Construction drawings.
- Safety and construction quality problems.
- Interferences in vendor and contractor operations by inspectors.
- Poor coordination of construction tradesmen, and construction equipment.

As isolated individual occurrences, each of these above listed problems might have little, if any, impact on the overall final project quality, cost and schedule. For example, an individual late design change by the Owner, an individual design error or an individual vendor equipment deficiency will, by themselves, have little or no impact on the overall final project cost, quality or schedule. All of the above risks result from a number of minor problems in the day-to-day work processes as well as team effectiveness. In other words, they are precipitated by the advent of a number of individually negligible risks, namely those associated with the work processes, procedures, systems, tools, communications and personnel employed on the project. The risks associated with all these aspects are virtually always considered negligible since all these aspects are assumed to be "fit-for-purpose" in a collective sense.

3. THE RISK ICEBERG

It is our experience that the relative frequency of risk in the various categories of risk severity increases roughly exponentially as one moves down the risk severity scale, as shown in Table 1 below. For every 5 critical risks, there may be 50 serious risks, 500 risks of secondary consequence and 5,000 minor risks on a given project. Therefore, Table 1 represents the "risk iceberg" of a project, since the project management team only "sees" the top end of the risk "iceberg". However, it is the "unseen" portion, the portion below the "waterline", which in fact in aggregation is more dangerous.

Project Stability is defined as the capacity of the project to accommodate risk.

Table 1: The Risk Iceberg

Project Risk Severity Classification	Relative Frequency of Risk Occurrence	Corresponding Risk Event Domain (Generic Area of Project Work)
Critical	5	Strategic, catastrophic risk event, a major external risk event, a major inherent risk
Serious	50	Problems with major component deliverables, key elements of the execution plan, major external risks
Secondary Consequence	500	Problems with minor component deliverables, work plan sequencing and coordination and interface management
Minor	5000	Problems with general project management processes, systems, controls

All of the above suggests that the project management team's approach to risk management should include:

1. A greater emphasis on proper and integrated project management processes throughout the project hierarchy.
2. An effective Project Delivery System and appropriate project management training at all levels of project supervision.
3. Increased levels of project planning and teamwork (partnering) by all the main project participants.
4. Drawing the "waterline" sufficiently low on the risk "iceberg" to assess the true amount of the threat minor risks pose to the project and to properly manage risk at all levels of the project work.

Project management teams cannot ignore lower levels of project risk, as they too must be managed properly. The above discussions also suggest that a more encompassing model can be designed to predict the probability of project outcomes, better than existing models which rely on empirical data from other projects, or only consider critical and serious project risks. The authors have named their model the Project Stability Model, with the intent to provide a reasonable prediction of the variances to be expected in the planned project objectives. Project Stability is defined here as the relative capacity of the project to accommodate risk, or unplanned change, at all levels without such events resulting in the cascade effect described in the introduction.

4. PROJECT STABILITY MODEL

It is axiomatic that the more "stable" a project is, the more likely that the project will achieve its planned objectives. This means that at project completion, there will be no significant cost and schedule overruns, performance objectives will be met and the work will meet quality expectations. The validity of such a model is supported by the general observations that:

- Inadequate planning results in major variances in planned project objectives.
- The seeds of project failure are planted very early in the project life cycle.
- Performance trends established early in the project life cycle, at best, remain stable until completion, but typically deteriorate.
- The amalgamation of many minor risks often causes major disruptions to the project delivery process.

The Model relies upon three metrics; the first quantifies the inherent risk of the project and the second and third are risk counterbalancing measures. Those counterbalancing measures are:

1. The "integrity" of the project's work processes, in other words, the quality of the Project Delivery System ("PDS").
2. The effectiveness of the project team and the supporting project organizations employed to deliver the project.

4.1. Inherent Project Risk

Even quite early in the project life cycle, it is possible to assess the relative amount of overall project risk, since many risks are "inherent" to any particular project. Inherent project risks generically include, for example:

- Project Type and Scale
  Relative to the sponsoring, participating and managing organizations, the greater the size of or inexperience in that type of project, the larger the risk.
- Project Complexity
  This includes aspects such as the number of interfaces (communications, coordination, and contracts), geographic separation of the project team, and the amount of overlap between normal sequential work elements.
- Level of Technical Innovation
  This relates to novelty of technology or process to the participating organizations, particularly the owner and the designer and to a lesser extent, the constructor. The higher the relative use of (or need for) new technology, the greater the risk.
- Perceived Priority of the Project by the Sponsor and Other Participants
  This refers to the priority relative to other organizational priorities, the greater the perceived relative priority of the project the lower the risk.
- Relative Depth, Ease and Certainty with Which the Project's Scope Can Be Defined
  This consists of the relative degree of "openness" regarding the details of the final "product" and the associated execution plan. The greater the ease, depth and certainty with which the project's scope can be defined, the lower the risk.

These areas and other project risks can be audited and assessed in terms of weighting and scoring for any specific project situation. Risks in each of the above areas, as well as other known specific risks, are evaluated in terms of the severity of the potential impact on the outcome objectives of the project. The severity can be measured, ranging from negligible to critical, as shown by example in Table 2.

The probability of the risk event, the potential maximum impact or loss of that risk event and the probability of the potential maximum impact or loss occurring are each assigned a value to enable the calculation of a risk severity score value.

Each of the three components must be objectively assessed to realistically score the risk severity. Impact and probabilities are assessed taking into account the planned mitigation for the project under evaluation. Individual risk severity scores are summed for all known significant specific risks, including the inherent risk areas, to obtain the Total Risk Severity Score value.

4.2. The Project Delivery System ("PDS")

The overall risk to the project is counterbalanced by the overall Project Delivery System "integrity". The "integrity" of the system is defined as the

Table 2. Inherent Project Risk Assessment

Risk Event Probability of Occurrence (A)	Risk Event Impact		Risk Severity Score
	Potential Maximum Impact (B)	Probability of Maximum Impact (C)	(A) x (B) x (C)
Most Likely (10)	High (10)	Most Likely (10)	Critical
80 to 100%	> 15% on outcomes	80 to 100%	513 - 1000
Probable (8)	Significant (8)	Probable (8)	Substantial
60 to < 80%	5% to < 15% on outcomes	60 to < 80%	290 - 512
Possible (6)	Moderate (6)	Possible (6)	Serious
40 t < 60%	2% to < 5% on outcomes	40 to < 60%	100 - 289
Less Possible (4)	Modest (4)	Less Possible (4)	Minor
20 to < 40%	1% to < 2% on outcomes	20 to < 40%	24 - 99
Unlikely (2)	Minimal (2)	Unlikely (2)	Negligible
0 to <20%	< 1% on outcomes	0 to <20%	8 - 23

measure of the Project Delivery System's quality, or alternately its "fitness-for-use". The higher the integrity the greater the ability of the systems and its processes to successfully manage and mitigate all project risks to achieve the project's objectives.

Strategically, the overall "integrity" of the Project Delivery System includes the employment of:

- Proper front end strategic planning and "gating" of the project prior to the official approval point (typically the signing of the Appropriation for Expenditure or "AFE"). This includes, for example, project selection, development of an effective project delivery strategy, stakeholder, risk and feasibility analyses.
- Appropriately rigorous project management processes (at all levels and throughout - all key participants). This includes appropriate front end planning, a comprehensive and effective project execution plan (and subsequent rigorous adherence to that plan), effective project control systems and effective change management processes. These project management processes must include all the functional areas of project management (planning, control, external stakeholders and issues, scope, change, quality, cost, time, earned value, human resources, communications, risk and procurement).
- Properly planned and high quality work processes that are implemented throughout (by all parties and at all levels of) the project. This requires that all work is properly planned, base-lined, mandated, initiated, coordinated, monitored, measured, reported, controlled and closed out.
- Sufficient funding and resources, a commensurate timeframe, and proper contingencies during all phases of the project.
- An appropriate contracting strategy including the appropriate allocation of project risk.

By objectively auditing and assessing (scoring and weighting) the "integrity" of these project processes against the potential impact of the inherent risk categories, the "stability" of the project can be measured. This "stability" must be regularly re-evaluated throughout the life of the project since risks constantly change and improvements are typically made in the PDS. In addition, this assessment becomes more comprehensive the further down the project timeline the project progresses.

4.3. Project Team and Organizational Effectiveness ("PTOE")

The third metric of Project Stability is measure of the project team and project organizational effectiveness. Recognizable and typical symptoms of weaknesses in intra-team and inter-team effectiveness include:

- Poor working relationships and communication breakdowns.
- Lack of alignment around expectations and outcomes.
- Lack of definition and agreement around roles and responsibilities.
- Poor project management practices despite following prescriptive methodologies.
- Performance expectations not met or understood.
- Little accountability for team or project organization performance.
- Intra-team and inter-team conflict.
- Failure to effectively engage team and team member strengths.
- Unresolved project issues which become conflicts and disputes.

These issues often arise because of the lack of an organizational commitment to team processes led by senior management. Those team processes include:

- Tools to regularly measure and manage team performance.
- Facilitated, inclusive and structured partnering between owners, designers, contractors and key vendors.
- Setting individual performance goals and accountability.
- Developing an appropriate organizational structure.
- Structured support from senior management from all key parties. This includes assistance by senior management, when problems are encountered.

Effective teams consist of sufficient numbers of project personnel, who are all properly experienced, competent and motivated in terms of their individual mandated, assigned, or contracted tasks. They also include vendor and contractor personnel who can provide the necessary goods and services on a timely and cost competitive basis.

To measure the overall effectiveness of the project team, the efficiency of all the traditional areas must be considered. These include:

- The communications and documentation employed on the project
- The mandates and contracts used with the project participants.
- The leadership and corporate support given to the project.
- The organizational structure used to deliver the project.
- How decisions, problems, conflicts, disputes, issues and concerns are managed on the project.
- The interactions and performance of the project team members.

5. CALCULATING THE PROJECT STABILITY

The results from the overall risk assessment for the project are combined with the scores of the Project Delivery System and the project team effectiveness to obtain a measure of the project's stability.

Project Stability Index ("PSI") = [$W^2_{\text{(PDS Integrity)}}$ x $W^3_{\text{(Team Effectiveness)}}$] / $W^1_{\text{(Inherent Project Risk Severity Score)}}$

$$PSI = \frac{W^2_{\text{(PDS Integrity)}} \times W^3_{\text{(Team Effectiveness)}}}{W^1_{\text{(Inherent Project Risk Severity Score)}}}$$

While the PSI value is a relative one on an industry wide basis and will therefore vary from one project sponsor to another, the PSI scores will be consistent within a given organization to relatively "rate" that organization's project's "stability". Since the criteria used to obtain the PSI score is relevant and objective, the resultant score is repeatable and reliable. In a stage-gated project approval process a pre-set PSI score can therefore be established as a gate condition. This forces "high risk" projects to take the necessary actions to improve their PSI score to an acceptable level prior to approval. Other benefits derived from the process include:

- Investment opportunities may be optimized (and prioritized) by identifying higher risk projects, facilitating better capital stewardship.
- The process assists in maximizing the business value from each project, as well as in "marketing" a (potential) project to other sponsors (or partners) or to financial supporters.
- A consistent and objective assessment of project risk is obtained across the full project portfolio.
- A practical and objective insight into any areas of the project which require improvement to enhance the project's probability of success.

- Problem or risk areas to be addressed may be properly prioritized.
- Identification of risk reducing actions is facilitated along with objectively measuring their impact by assessing the change in the PSI score.
- The process aids in determining practical project staffing requirements.
- High risk partners and contractors/suppliers may more easily be identified along with the specific steps required to reduce the project risk to thereby improve the project "partnering" process.
- The process provides an objective and consistent basis for deciding to either delay or even "kill" a project.

6. APPLICATION OF THE PROJECT STABILITY MODEL TO IMPROVE PROJECT OUTCOMES

Based on the authors' collective experience, all projects which by completion had incurred substantial cost and schedule overruns, or suffered seriously compromised performance, would have consistently shown low or inconsistent Project Stability ratings. Conversely, those Projects which would have shown high and consistent Project Stability rating met the planned objectives at completion.

The Stability Model is an effective method for owner organizations to evaluate and predict the probability of project success both early and throughout the project duration. Most significantly, a Project Stability review would identify and prioritize project risks, incomplete or missing processes in the Project Delivery System, and project team competency gaps. Specific remedial actions could then be taken to improve the Stability score and thereby the probability of meeting the project objectives. For owners particularly the following benefits would also accrue:

- Reduced overall project costs and durations.
- Project control that is real, effective and readily auditable.
- Improved project quality and other outcomes (e.g., EH&S).
- More productive and more creative project teams.
- Better management of project risk.
- Better capital stewardship and capitalization of opportunities.
- Less frequent conflicts and disputes.

The application of the Project Stability Model is of particular relevance to owner organizations that have taken the strategic decision to become more involved in the planning, monitoring and management of their projects rather than relying on the management processes, procedures and competencies of their contractors. The model can also be applied with equally validity and benefit to any construction contract situation.

7. CONCLUSION

The Stability Model can be used to understand the common situation in which the manifestation of a single small risk event (which would by itself be assessed as a negligible risk) precipitates a cascade of other risk events and finally leads to a major problem on the project. This situation may also occur on a company operational level, suggesting that this model could be applied (with some necessary changes to the performance assessment parameters) to companies, other organizational and societal groups and economic systems to predict their risk of “failure”. This observation also supports the application of the “butterfly effect” (from the theory of chaos) to most business, government and other organizational endeavours. They are all systems wherein relatively small perturbations cause a marginally stable system to become unstable and fail. Therefore, the “failure” of most organizations or systems should be regarded as much internal as external , wherein the system “integrity” is insufficient to withstand the “pressures” on the system that arise.

This model also helps to explain why small projects with minimal controls and few documented quality processes are, in many cases, still successful. Their small integrated teams with high levels of communication allow rapid identification of problems and response to those problems. In the Stability Model such teams would receive a high team effectiveness rating. Their competent, motivated and managed participants are frequently able to fix problems before they “multiply” and cascade into a major problem. Moreover, such teams exhibit high levels of project “ownership” and accountability by all the individual project team members on a day-to-day basis. Further, their senior management actively supports their team members by direct involvement in the project work to ensure consistently high work quality and rapid problem resolution. Some larger scale projects are successful because they emulate these characteristics throughout their participant organizations.

To attain integrity of the project delivery system, proper project management processes must be applied to all levels of the project organization.

Due to the “self similar” nature of managing the project work throughout the entire project, the inherent risk, team effectiveness and Project Delivery System integrity components must be evaluated to assess the stability of each important element of the project. This is particularly important for contracting relationships on a project, for it ensures that all parties to the contract are properly able to manage all the risks and potential impacts for which each is responsible.

As stated earlier, the Project Stability Model illustrates the necessity of applying proper project delivery practices throughout the entire project. The application of the “self similarity” concept from fractal geometry theory must be applied to the planning and management project work. Mathematically, the term “self similarity” is applied to situations wherein the same patterns are repeated at all scales. It is not sufficient to apply project management practice only to the “top end” of a project. Project management practice must also be applied to all project work elements. Similarly, quality processes must not only be applied to key aspects of the engineering design or construction installation work, but to all aspects of project work, including to all levels of management of the project.

The construction industry has been singularly successful in dramatically improving project construction safety, since all participants from the construction trades to the most senior manager are made responsible for safety on the construction site. This same “culture” for managing project risk and therefore applying appropriate project management practices must be instilled into team members on larger projects. However, the drive for reducing project risk must come from the project sponsor, just as it did for project safety.

The Revay Report is published by Revay and Associates Limited, a national firm of Construction and Claims Specialists, assisting owners and contractors in achieving profitable and trouble-free construction projects.

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