PICKING SUCCESSFUL PROJECTS BY USING THE PRISM LL^{TM} MODEL

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The Project Risk Identification, Selection, and Management model (PRISM^{TM}) is a process for improving the success of project procurement and knowledge management. It consists of three component parts (PRISM l, PRISM ll and PRISM lll), which have been developed over the last five years. PRISM l has been refined over the past four years by working with several companies who have developed their own customized versions of the model. PRISM 11 has been in the development phase over the past two years. The PRISM 1 Model was designed to be used with projects where there was high quality historical data available for analysis; therefore, it was able to use the traditional tools of risk management, such as Expected Monetary Value, Utility Theory, Pair-Wise Comparisons and Critical Risk Ranking Matrix. This helped companies develop an effective bid-no-bid decision prior to committing significant resources to create a full-scale estimate and bid on the project with the highest profit potential. Another output of the Model was the Project Profitability Predictor. In so doing, PRISM 1 proved to be an improved method for both qualifying and quantifying project risk and opportunity information, which was used to prioritize, manage and mitigate risks before going to contract and then throughout the project. In this way, the model served as a template to store quantitative and qualitative data about each project, creating an historical database and effective knowledge management system designed to capture essential information on past projects and, thereby, reduce the number of known-unknowns on future projects. PRISM ll, building on the strengths of PRISM 1, incorporates more sophisticated risk management tools, including Monte Carlo simulation. PRISM lll, scheduled for release over the next two years, will use neural networking, genetic algorithms, and hybrids, such as fuzzy-neural. These enhancements of the PRISM model will be better able to focus on projects with significantly fewer knowns, b) projects with more known-unknowns, or c) unique projects with more unknown-unknown risks.

Keywords: knowledge-based systems, modeling, procurement, profitability, risk mitigation

INTRODUCTION

Too many companies are still going out of business within five years of start-up. According to Dun and Bradstreet, since 1997 approximately 56% of the companies, which generate business by responding to Requests for Proposals (RFPs) have gone out of business. There are various reasons for their demise; however, negative cash flow remains one of the prominent reasons cited. Companies are bidding too much work that is either not a good match for their asset base or beyond their geographical or technical ability to control properly. (*Engineering News Record* 1997)

Several studies have shown that the cost of resources to prepare a complete hard-bid proposal for a project runs between 1/4 to 1/2 percent of the cost of the project. (Bajaj, Lenard, Oluwoye, 1997; De la Garza, Rouhana. *Neural Networks* 1995; De la Garza,

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Rouhana, *Survey*, 1995) That means that if a company has to bid four $1 million projects in order to go to contract on one, the assets wasted on trying to procure the three unsuccessful projects could amount to as much as $150,000 dollars. That is, the company invests approximately $150,000 before it is ever able to go to contract on the successfully bid project. Therefore, it is extremely important for companies to make quick, accurate decisions regarding which projects to bid before committing the crucial resources to obtain the contract.

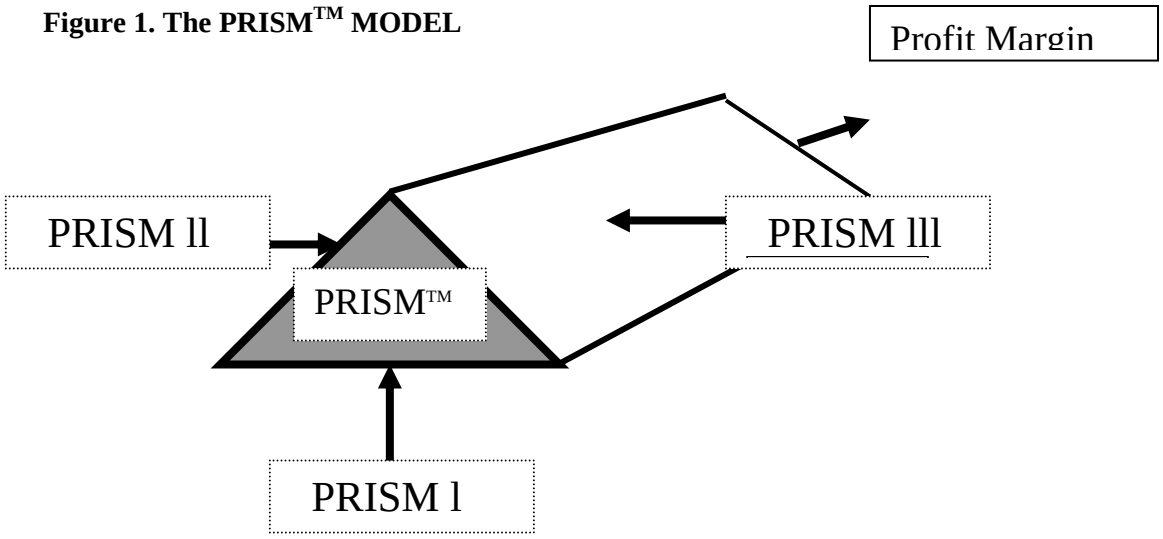
Most companies encounter extremely high risk due to such factors as the uniqueness of every project and the exposure to external elements. (Kim, 2000) The majority of companies prepare cost estimates based on a traditional single figure cost estimation approach. (Leung, Mok, Tummala. 1996) Although the estimators often consider risks, those risks are rarely reflected in the final estimate in a formal, systematic way. (Dexter, 1999; Diekman, Pecosk, Songer 1997)) The most common method for protecting the company from potential risk is to add a contingency sum to the estimate. However, this approach has a number of weaknesses, including:

- The contingency figure is usually arbitrarily arrived at and may not be appropriate for the proposed project;
- Estimators have a tendency to double count risks;
- A percentage addition still results in a single-figure prediction of estimated final cost, implying a degree of certainty that may not be justified by the data available;
- This method assesses risk only as a negative variable and doesn't consider any positive potential (opportunity).

As a result, the traditional single-figure approach can be inadequate, misleading and cost inefficient. (Ranasinghe, 1997) Therefore, industry requires not only a different approach to managing the risks associated with project procurement but also a tool which organizes and quantifies project selection information and stores valuable project procurement knowledge appropriately for future decision makers.

The PRISMTM Model (See Figure 1 below) was designed to approach managing procurement risks differently, more innovatively, in the rapidly changing business environment. It also provides tools to organize and quantify project selection, which are easily stored and reusable. The model itself incorporates three components (PRISM l, ll, lll), which combine to predict and, therefore, increase overall company profit margin:

Figure 1. The PRISM™ MODEL



The development of PRISM l was presented in detail in previous research (Auchey, 2003) The lessons learned from the development of the PRISM 1 were used in the development of the PRISM ll model, presented in this paper.

BACKGROUND: PRISM 1

PRISM 1 focused on creating a customized list of questions, which were quantified and ranked using Expected Monetary Value, Utility Theory, Pair-Wise Comparisons, and the Critical Risk Ranking Matrix. In this way, the model overcame one of the greatest difficulties associated with project selection models: customization to specific company operations. Once customized, the information reflected specifically how good a match a project was to the inherent abilities and assets of a company. (Auchey, 2003)

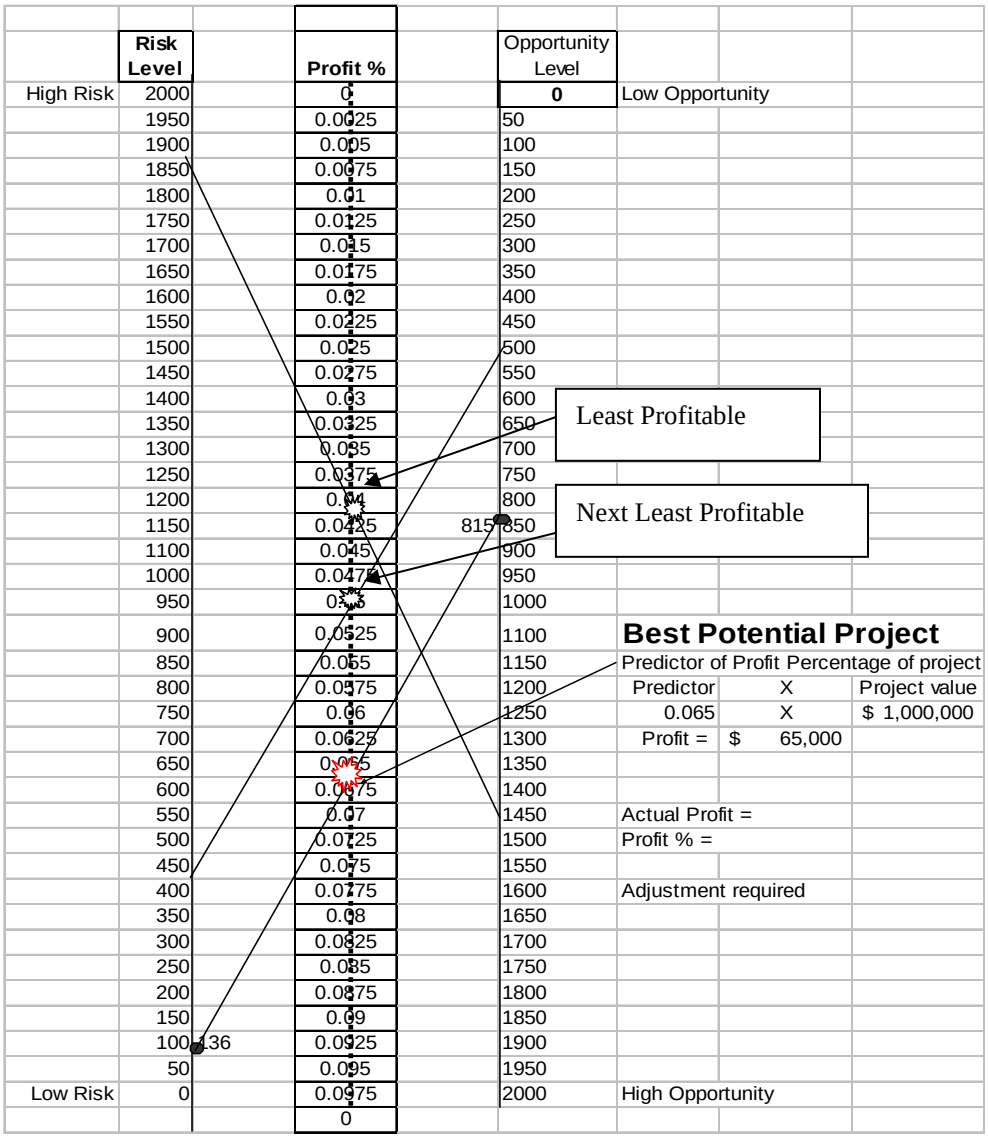
Moreover, PRISM 1 provided a systematic approach in the identification and assessment of potential positive as well as negative risks, which, in turn, provided management with a tool to help project managers choose appropriate courses of action in managing project selection and risk. In this way, critical knowledge was captured in a format that was easy to access, analyze and use for future project selection. Indeed not only did PRISM 1 provide an innovative approach to project risk analysis and procurement it also gave managers an at-a-glance quantitative assessment of the project as compared to other possible projects. Albeit the tool developed was unique to the operations of the company for which it was developed, it proved robust enough to be used as a starting point tool for the development of customized templates for small, medium and large companies with different types of projects, assets and competencies. In this way, the PRISM l was further used to provide the basic structure for multiple industry-wide use in risk management, project selection, and knowledge management. (Auchey, 2003)

Another unique deliverable of PRISM 1 was the development of the Profitability Predictor (See Figure 2 below) To date the PRISM ™ Model is the first published attempt at producing a risk management tool that expresses profitability of potential projects in monetary terms. When using the PRISM 1™ Model, the project manager placed the opportunity score on the right vertical axis and the risk score on left vertical axis. The intersection of the scores on the center profitability index determined the final predicted profit value of the risk/opportunity assessment for a specific project.

The location of this score on the index helped determine the quality of an opportunity and served as an indicator of the level of risk to be managed for overall project success. The primary advantage of this Profitability Predictor is that the user can input the relevant data from several possible projects and then compare them to see which had the higher potential for profitability. This way the user can also decide which project deserved to have company resources allocated in order to win the project before they had to go through a complete and expensive (1/4% to 1/2% cost of the project value) project procurement process. Thus, PRISM 1 not only utilized a different approach to risk quantification, using a combination of Decision Tree Analysis, Utility Theory, Expected Monetary Value and Risk/Opportunity Assessment Models but also created a Project Profitability Predictor, which could house quantifiable data regarding the profitability of not just this project but be used to predict profitability on future projects for this company. (Auchey, 2003)

On a final note regarding risk quantification, project estimates are often based not only on the knowledge of the estimators and schedulers as well as on the experience and data for similar projects completed previously, but also on a large number of assumptions made regarding productivity rates and material prices. Many components of the projects are prone to variation, such as material prices. Other items such as labor productivity rates can be sensitive to many factors, including weather, temperature, state of the economy, union involvement, and project duration and cost. This model is intended to provide a logical mechanism for predicting the extent of these variations and forecasting their impact on the project. The PRISM ll and lll models have further refined the impact of these known-unknowns through the use of more theoretical and empirical based risk tools. The principal use of the output from the PRISM 1 Model was not to discourage a company from bidding on projects with high risk but to identify risk and encourage risk management in a more cost effective and timely manner. (Auchey, 2003)

Figure 2. Profitability Predictor



Information from twenty (20) past projects was used to develop the PRISM l model. The research conducted using the model indicated that as more good historical data from past projects was generated using the process and templates, the accuracy of the model as a predictor of project profitability improved significantly. The participating companies recognized the value of the model as a powerful means of improving project procurement. (Auchey, 2003)

During the development of PRISM 1, several issues needed to be addressed. For example, the model received input initially from project managers and estimators who were intimately familiar with each of the projects being evaluated. As they answered each of the risk and opportunity questions, they thought they were responding in terms of the risks and opportunities that existed back at the time the company was initially evaluating the projects as worthy of full estimating effort. It became apparent that their judgment (utility theory) had been influenced by what they actually knew to be valid risks and opportunities from the perspective of hindsight. Therefore, the profitability predicted actually was reflecting the potential profitability of the project after all of the risks and opportunities had been realized. This probably should not

come as to too much of a surprise, since it would be difficult for the project managers or estimators to divorce themselves from the realities encountered in the project. The data points resulting from the input from past projects correlated very closely with the actual profitability for each project. (Auchey, 2003)

As the results from more projects were collected, the PRISM 1 model was fine-tuned to reflect this additional information and suggestions for improvement in the model. For example, when researchers found that several of the questions regarding potential risks or opportunities have 0 or very low expected value, the natural question arose "Is this issue really that important as it relates to the way this company does business on this type of project?" If not, eliminate the question and look for others that suggest greater impact on the profitability of the project. (Auchey, 2003)

Another question that arose was "Are we missing issues that should be included but were not because we assumed they were not of major impact on the profitability of the project for this company?" This possibility was highlighted when several project results understated the actual projected profitability of a project. Further study indicated that this particular company was uniquely successful on projects that had a large amount of earthwork, as mentioned earlier. Additional questions were formulated both on the risk and the opportunity side. These modifications provided more accuracy in predicting profitability on future projects with similar characteristics. (Auchey, 2003)

Furthermore, as modifications to the model are applied to future projects, time and experience will further validate the accuracy of the predictions of the model. In any event, the risk management process has been improved through the use of the model as a tool to help create prioritized lists of risks and opportunities to be mitigated. Rarely is there sufficient time and resources available to address all risks and opportunities; therefore, the process should be extremely helpful to management in prioritizing their risk management mitigation and control efforts. At least project managers and estimators will have invested their management time and resources on the right projects and in the risk areas that have the greatest return on investment.

- Make high level go/no decisions on bidding new projects
- Identify risks and opportunities to be addressed before going to contract
- Quantify and prioritize risks and opportunities
- Allocate risks to the party best able to handle the risk
- Manage those risks which cannot be transferred
- Document risk/opportunity events from past projects
- Reduce the cost of resolving disputes
- Place a limit on a firm's financial exposure in the event of a claim
- Archive decision making wisdom of top management for use by future generations (Auchey, 2003)

THE PRISM LL MODEL

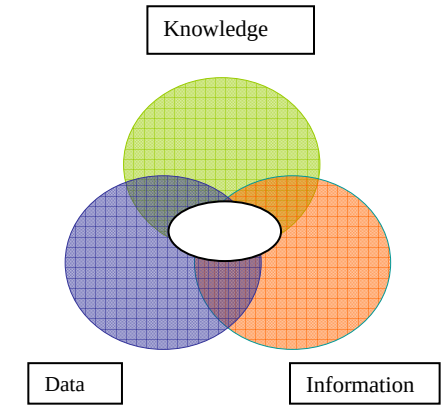


Figure 3:
CORRELATION OF THE THREE FACTORS

The PRISM II model described in this paper has been designed to approach managing responses to requests for proposals differently, more innovatively, in the rapidly changing business environment. In addition to using the Monte Carlo simulation to determine the final percentage of variances in profit, it also provides a tool to create a lessons learned database, as it correlates data, knowledge and information to form one Model. (See Figure 3)

The PRISM II Model, like the PRISM I, was designed to assist a company in determining early on if the project they are going to bid on is profitable enough. Thus, the first step was to develop a specific list of project selection questions (Step1: Identification). In so doing, it overcame one of the greatest difficulties associated with project selection models: customization to specific company operations. Customizing the project questions is one of the model's unique characteristics, for once the potential risk list has been customized, it can actually determine how good a project is relative to the inherent abilities and assets of a company. The model can be used by both specialty and general contractors.

In addition to the tools of risk management, such as expected monetary value, pair-wise comparison, and critical risk ranking matrix, used in creating PRISM I, PRISM II included the Monte Carlo simulation to help companies develop a more effective bid decision making tool. The word simulation refers to any analytical method meant to imitate a real-life system, especially when other analyses are too mathematically complex or too difficult to reproduce. (Goldman,1993) Without the aid of simulation, spreadsheet models like PRISM I will only reveal a single outcome, generally the most likely or average scenario. Modeling risk analysis uses both a spreadsheet model and simulation to automatically analyze the effect of varying inputs on outputs of the modeled system. The Monte Carlo simulation tool was used in the final prediction stage to derive a range of estimates for a single project, which would predict a potential profit percentage from the most pessimistic to the most optimistic.

The use of the PRISM II model began with the company creating an expandable set of project selection questions online (Web based) relative to potential project risk and opportunity. These questions were then quantified using Expected Monetary Value Calculations, the probability of occurrence and the potential impact of risk events using a blind linear gradient scale. Whereas the PRISM I model used only the rating system from numbers 0-10 for the probability of occurrence and 0%-100% for the potential impact of risk/ opportunity events, PRISM II included a gradient quantification system, which gave the user the added advantage of visually and mentally determining the relative probability and impact of occurrence, and thereby ranking them. The final value of the profit percentage was predicted using the Monte Carlo simulation. The data generated was then plotted to determine potential project profitability of one project relative to other projects being considered. Therefore, by using the PRISM II Model, the company decision-makers could derive a range of

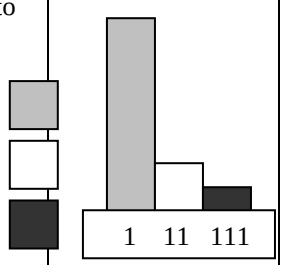
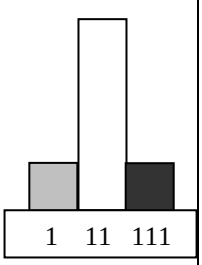
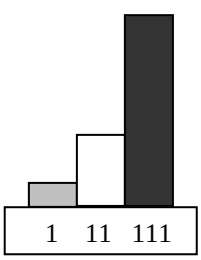
estimates for all potential projects, thereby, providing critical information for them to make more effective decisions prior to committing significant resources to create a full-scale estimate.

IMPLICATIONS FOR THE DEVELOPMENT OF PRISM 111

It is foreseen that a PRISM 111 component will be used to accommodate those projects that have a preponderance of unknown-unknowns, i.e. those projects that contain scope that has never been built before. In these cases, tools such as PERT and Monte Carlo simulation might be used to make initial predictions. In addition, interesting work is being performed by researchers around the world, such as Dr. M. J. Mawdesley of Nottingham University, UK, utilizing genetic algorithms. (Mawdesley and Bennet, 2000)) This researcher is investigating the potential for a PRISM 111^{TM} model, which would incorporate genetic algorithms and be designed to accommodate new concept projects, where most of the anticipated risks are of the unknown-unknown variety. This tool could also be used with new and innovative projects (i.e. no proved data) where there is little or no expertise (i.e. no experienced decision-maker) or knowledge (i.e. no historical data base).

The final composite PRISM^{TM} model will benefit from the appropriate input from each of the PRISM 1, PRISM 11 and PRISM 111 components. Table 1 (See below) presents a comparison of the three components of the PRISM Model to indicate a) the type of risk based on the historical data associated with each, b) the risk analysis tools and methodologies that might be used, and c) the relevant input from each component to the PRISM ^{TM} .

Table 1. Comparison of PRISM 1, PRISM 11 and PRISM 111

PRISM^{TM}	PRISM l	+ PRISM 11	+ PRISM 111
To be used on projects when risks are mostly…	*Known* i.e. repeated projects and good historical data	*Known-Unknown* i.e. a mix of repeated with new project elements and/or limited historical data	*Unknown/Unknown* i.e. new projects with very poor or non-existent historical data
RISK TOOLS	-Decision Trees -Neural Network -CRR -EMV -Utility Theory -CPM	-Decision Trees -Hybrid of Neural-Fuzzy -CRR -EMV -Utility Theory -PERT -Monte Carlo	-Utility Theory -Fuzzy Logic -PERT -Monte Carlo *-Multivariate-Entropy* -Evolutionary-Strategies -Genetic Algorithms
Relevant Input from Components l, ll, and/or lll to the PRISM^{TM} MODEL % of Knowns……. % of Known-Unknowns… % of Unknown-Unknowns.			

Each component (1, 11, and 111) will contribute the highest quality of information it is capable of producing with respect to a) quality of historical databases, b) experience level of project manager, c) uniqueness of project and d) capability of risk tools. Additional work and further refinement of the present PRISM^{TM} Model will result from the data collected from these three components.

CONCLUSION

Ultimately, a model is only as 'used' as it is perceived to be 'useful'. Indeed, the authors recognize that many critical decisions are governed by some very simple yet powerful variables that can overshadow more significant ones. In interviews with over 200 companies, the authors determined that there are certain variables (over 600 identified to date) that influence the company's final decision as to how much profit shall be added to the bid. Among these, an overwhelming influence is exerted by the question: 'How badly do we want or need this project?' Indeed, this influence exerted a significant impact on why the potential profit of one of the projects was not accurately predicted by the PRISM l modeling and fell outside allowable variance. The company wanted to win this project so badly that many of the risks predicted were overshadowed by the need to win the bid. These variables are now being quantified and incorporated into the model on a custom company project basis in order to improve the accuracy of the PRISM^{TM} Model and the effectiveness of the process of procuring successful projects. Furthermore, the Model is designed to capture and facilitate a lessons learned database, designed to improve knowledge management.

In short, this model was purposely designed to incorporate the best of the time-tested traditional tools of risk management with the most innovative techniques and current best practices. In the end, the goal of risk management is to improve project success, increase overall profitability and, ultimately, significantly reduce this 56% failure rate for businesses.

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