Evaluation of the TxDOT Partnering Plus Program

BACKGROUND

The Texas Department of Transportation Continuous Improvement Office launched the Partnering Plus Program in December 1996 (TxDOT, 1996). This program is the embodiment of the decision to implement partnering on a large scale throughout the state. The new program promulgated a policy that required partnering to be used on all TxDOT construction projects. There were two options available for partnering.

- Formally partner the project utilizing a designated facilitator
- Informally partner the project using project personnel to facilitate

As a part of the Partnering Plus Program, facilitators from inside TxDOT and its contractors were trained. Additionally, training for project personnel and others was conducted throughout Texas to ensure that informal partnering sessions conformed to the requirements thought to be necessary to ensure the maximum benefits from the exercise. As a result of this decision, the course of this research was shifted away from creating a decision-making system for identifying projects to partner. The focus was easily moved to the creation of a method to assist the Department in identifying those projects that would benefit from the investment of time and money in formal partnering sessions. The data that had been collected formed a body of knowledge with regard to the performance of partnered projects in comparison to the performance of non-partnered projects. This statistical data has allowed the research team to identify the types of projects that marginally benefit from partnering as opposed to those which displayed significantly enhanced performance.

In the spring of 1998 major leadership and organizational changes were effected within TxDOT that again impacted the partnering research focus, particularly Task 2. TxDOT no longer requires that a construction project be partnered. As the partnering research has shown, the maturation level for both TxDOT and general contractors is very high since the inception of partnering within TxDOT. The decision whether to partner or not is now vested within the TxDOT districts.

Partnering construction contracts is popular throughout US and in certain other countries. The term Partnering evokes different meanings to different sectors of the engineering and construction industries. Among the designers and builders of privately-financed projects, Partnering is a strategic relationship that is developed for relatively long periods of time and for multiple projects. These strategic Partnering projects garner many advantages to their members. The main advantage is the development of an understanding of the partners' motivations, trustworthiness, and means of communication. This understanding allows one partner to gauge the other partner's potential reactions to an impending crisis and encourages the honest sharing of bad news in a timely manner. This permits joint action to avert or minimize damage to the successful completion of the project in question.

Private strategic partnering has an advantage over counterparts in the public sector in that the private entities are relatively free of regulation on the form and the substance of their internal operational activities and contractual relationships. Public agencies must answer to lawmakers, regulators, and the general public. Thus, the freedom to develop a longstanding, strategic Partnership with private organizations is greatly diminished if not eliminated altogether. As a result, agencies like the Texas Department of Transportation (TxDOT) have confined their Partnering activities to single project, team-building seminars and have not yet attempted to establish multiple project Partner relationships with entities in private sectors. TxDOT has also looked for ways to improve their Partnering efforts and has developed the Partnering Plus Program. Under this program, TxDOT and a private contractor join together in a Partnering arrangement to accomplish the work covered by the contract. The Partnering Plus Program provides two ways of Partnering: formal and informal.

In formal partnering, there is a facilitated meeting that covers one or more modules of the Partnering process. Initially the owner and the contractor mutually agree upon an agenda, a location and the format, and the scope and attendees. The contractor and engineer select a facilitator. This facilitator must have technical knowledge to lead and guide discussions. The facilitator will make all the meeting arrangements, meet with the engineer and the contractor, and set the final agenda prior to the workshop. The facilitator discusses all issues presented by either party and is flexible to the needs of the Partnering team. The facilitator also ends the session when both the engineer and contractor agree that the session is not following the agenda or achieving planned objectives. The facilitator acts as a neutral party seeking to advance proactive pre-project planning. In informal Partnering, a non-facilitated meeting is set up which, at the minimum, covers communication issue resolutions and issue escalation processes. The engineer and contractor agree on an agenda and add it to the pre-construction conference.

WORK PLAN STATEMENT

TxDOT's Continuous Improvement Office awarded a research contract with two phases to Texas Tech University, namely, to identify and quantify the impacts and benefits of their Partnering effort and to develop a management tool. The management tool is to provide guidance to project managers responsible for determining the type of Partnering to use (informal or formal). The study addressed the following problems.

- Analysis of the costs and the benefits of partnering on TxDOT projects
- Development of parameters and criteria to measure the effectiveness of partnering
- Use of these parameters and criteria to create a management tool by which future construction projects can be evaluated to determine the appropriateness and potential benefit of using both formal partnering and informal partnering on a case by case basis
- Assessment of attitudinal feelings toward the partnering process within TxDOT and their contractors

The research team used a three-pronged, global approach that is responsive to the six tasks (as amended by the series of policy changes since the start of this research) outlined in the problem statement to solve the problem. First, historical data from TxDOT projects and literature was gathered, sorted, and analyzed from three perspectives (government, contractor, and private business practice) to identify trends and significant differences. These were used to provide project-specific inputs to a database and provide a reliable estimate of a future project's relative suitability for Partnering.

Cost index number theory, fuzzy logic, and neural networks were investigated to achieve this purpose. Fuzzy logic had been successfully used by the Corps of Engineers to quantify qualitative data on potential Design-Build contractors (Paek, J.H., et al, 1992), and it was felt that this approach was very close to the required approach for Partnering. It was found that while cost index number theory will work quite well in this situation, fuzzy logic requires the development of an expert system to be totally effective. Neural networks seemed to provide a promising mechanism for this solution. This was rejected as being too complex and abstract. The focus of the research shifted towards differentiating between formal and informal partnering plus the analysis of historical records as affecting non-Partnered and Partnered projects

The Work Plan roughly followed the six tasks listed in the original research problem statement. Some of these tasks were necessarily amended due to major policy changes implemented by new leadership within TxDOT. The project was divided into six major tasks with which must be accomplished to adequately cover the research topic. This report will briefly recapitulate the task descriptions and describe the work completed on each. The quantitative and qualitative results attendant to these tasks are presented in the analysis of results.

The shift in focus to study a method to determine the type of Partnering to be used on a given project did not significantly impact the project milestones. The one point that caused any concern was the overwhelming response to the detailed Partnering survey questionnaires. While this has given us more data than expected, it bodes well for developing findings with a high degree of statistical significance and the potential for producing the first definitive study on the subject of Partnering. Additionally, it was found that some of the desired data points are not available in digital records. Having to collect data in widely dispersed sets of paper records on over 400 projects was determined to be unrealistic, and the required data set was modified to maximize the use of those records which were readily available in computer searchable form.

The work tasks associated with the research are restated, and a synopsis of the work status is summarized. Analysis and findings are delineated in the analysis of results.

Task 1: This task includes both the literature review and the tabulation of data from TxDOT's records. It consists of the following five subtasks.

Subtask 1A: This subtask is the collection of cost and benefit data to determine the total TxDOT investment to date in its Partnering program.

In actuality, the data was not as readily available as hoped by the research team. It was found that some of the data resided in the Office of Continuous Improvement, and we were able to gather that data. The remainder of the data, specifically the participant cost, is only available in the Districts. Additionally, the actual costs would be difficult to separate inside the basic

accounting system. In discussion with the Project Director, it was decided to conduct a survey of all Area Engineers to determine the cost to participate in an average partnering session. The survey was completed and the results of this subtask appear elsewhere in this final report as Tables 1 and 2.

Subtask 1B: This subtask involves the collection of project cost and schedule performance data on both partnered and non-partnered projects to determine parametric factors for inclusion in the partnering model.

The informal partnering session held in October 1996 was attended by members of the TxDOT Continuous Improvement Office. As a result, data of this nature was quickly located. As is often the case, some of the desired data was unavailable and not constructable. This is specifically true for project information regarding schedule impact factors. Basically, the only data of this nature that we could find was the typical project start and completion dates as well as information on number of days of liquidated damages assessed against each project and the number of additional days allowed. Data collection and reduction on 204 partnered projects and 204 non-partnered projects was completed.

Subtask 1C: This subtask involves sorting cost data to identify trends and possible parameters for partnering model.

All necessary data analyses were completed. The presentation of these results appears in the analysis of results.

Subtask 1D: Subtask 1D includes the analysis of the results and the identification of factors that promote accrued benefits.

This subtask was accomplished using standard statistical analysis techniques. The mean, standard deviation and variance has been computed for all data points. Additionally, projects were grouped by contract amount to give the researchers a feel for the variation of desired data points with regard to project size. The data statistics are presented in the analysis of results.

Subtask 1E: This subtask involves conducting a literature review to ensure that the state-of-the-art is well defined and understood during the course of this research project.

Work on this subtask did not produced expected data with regard to existing systems to quantify partnering benefits. Since the last interim report, no additional inputs were received that could be construed as potential models for measuring partnering benefits.

Task 2 (Amended): Originally and as reported in the last interim report, this task was to explore opportunities to exploit partnering in "nontraditional" contracts and relationships within the Department and among its customers and stakeholders. With the exception of Subtask 2C which was completed at the beginning the research project, initial work on this task was to begin in the late spring of 1998. Before commencement of work, the team reviewed the planned approach in light of information gained in the first year of the project. However, before work was initiated on the remaining subtasks, TxDOT experience major changes in leadership and organization that

subsequently redefined the focus of Task 2. With the policy change in the Spring of 1998 which in essence now allows the decision whether to partner a given project or not to be vested with the TxDOT district, the TxDOT Deputy Director in telephone conversation with the principal research investigator amended this task. Basically the research team was directed to develop a "checklist" which would provide those TxDOT officials responsible for deciding whether or not to partner a given project key factors to consider in arriving at their decision

Subtask 2A: Subtask 2A includes the development of a checklist for use as a management tool for identifying the pros and cons of partnering a given project. The checklist developed is shown in the implementation plan.

Subtask 2C: As research and development contracts are an integral and substantial portion of the TxDOT budget, conduct an experiment in partnering "nontraditional" contracts by formally partnering this research contract.

An informal partnering session was held in Austin during October 1996. The session was well attended by appropriate members of the Department. Two of the three researchers were able to attend. The primary benefit of the session became the clarification of the requirements of this effort by TxDOT. The open channel of communication between the researchers and the Project Advisory Group greatly facilitated the initial efforts in data collection and the development of a Best Practices Survey which is directly responsive to the Project Director and the Departments need for specific information. The other important product of the session was a redesigned schedule of deliverables that will better serve the needs of the Project Director to provide information to Research Management Committee 1.

Task 3: The work associated with this task generally involved the development of survey questionnaires, their distribution, and an analysis of the results.

The focus was in discovering any parameters used by other agencies, both public and private, which could be used to measure the benefit and impact of partnering on their projects. The work was organized in three subtasks.

Subtask 3A: This subtask includes a review of the literature to find surveys of a similar nature that may have been used in previous studies.

The literature review uncovered four primary surveys on this subject. The most valuable was a survey done in conjunction with a Master's Thesis at the University of Texas on early partnering efforts of the Department. There was also a survey completed by the Ohio Department of Transportation. We found surveys done by the Corps of Engineers and the Naval Facilities Engineering Command as well. Information found in the literature was combined with information from this project's informal partnering session to form the basis of the surveys that were developed for subsequent subtasks. Detailed findings of the literature search are presented in the literature review.

Subtask 3B: Subtask 3B was to prepare and distribute a survey that asks the surveyed population to define how they measure the benefits and impacts of partnering.

The content of the survey was coordinated with the data collection plan for Task 1 to ensure that the survey's results could be correlated with TxDOT historical data to aid in the identification of parameters to measure partnering's effect on contracting systems. A two-phase approach was taken to distribute the surveys to public and private agencies. First, a preliminary survey was sent to all possible addressees and its results were used to target those organizations with the best information for the detailed survey. This permitted the team to filter out those agencies who had never used partnering and more importantly, those who had but would not be expected to respond to a detailed survey. It also helped us identify subject matter experts in each organization so that we could direct the detailed, second survey to the correct person who had the requisite information that we needed. The results of this effort are presented in the analysis of results.

Subtask 3C: Reduce the survey output and determine a "best practice" method of measuring benefit and impact. This task was completed, and the results are summarized in the analysis of results.

Ancillary Tasking Resulting from Mini Project Partnering Session

At the initial project partnering session, TxDOT requested that a questionnaire be developed and distributed to a sample of TxDOT field personnel. The purpose of the survey was to assess TxDOT field personnel feelings as to the progress of their partnering effort. The last such comparable measurement of TxDOT personnel was accomplished in January 1995 as part of a research project by a graduate student at the University of Texas (Grajek, 1995). That survey was reviewed. The same questions were repeated in the survey developed by the Texas Tech researchers, particularly those questions assessing attitude toward the various aspects of the TxDOT partnering effort. This approach allows TxDOT to use the Grajek report more or less as a baseline for comparison with the latest survey results.

A copy of the survey was developed by Texas Tech researchers and forwarded to a sample population of TxDOT field personnel, contractors, and external facilitators. A quasi-sampling approach was selected in which ten surveys were sent to every TxDOT District Engineer for random distribution to field personnel. Of the 250 TxDOT surveys distributed, 184 were completed and returned for a 74% response rate. Of 238 contractor surveys, 68 were returned and resulted in a response rate of 29%. 100% of the twelve external facilitator surveys were returned.

Task 4: Due to the fact that no reliable metric for partnering could be found, work on this task could not be accomplished. After discussions with the Project Director, it was decided to substitute a study of informal partnering which follows the same form and format as the survey of TxDOT field personnel and contractors in Task 3. Respondents will be asked to identify the criteria they currently use to select formal partnering over informal partnering. This data was used along with other data analyses to prepare a partnering checklist as a management tool to be used as appropriate for management making this type of decision on future projects.

Task 5: The work associated with this task will concentrate on identifying and quantifying criteria to compare the performance of partnered projects to the performance of non-partnered projects.

A statistically significant sample size for both partnered and non-partnered projects was determined. With this number, projects were randomly selected from among the available pool of projects. Care was taken to ensure the statistical integrity of the process. Additionally, an equal number of projects in both groups were taken to prevent the skewing of data that was apparent in a previous study which used unequal sample sizes. Projects were grouped according to contract amount and unit measure size to permit trends between large and small projects to emerge and become apparent to the analyst. Standard statistical measurements, as previously described in the Work Plan, were used to provide a comparative analysis in the cost and schedule categories. This work and the results are presented in *Chapter 3 – Analysis Results*.

Task 6: This task will synthesize the output from the preceding five tasks in developing a management tool which will can be used by management to decide whether to formally partner, informally partner, or roll-up in the pre-construction meeting upcoming projects.
This tool is presented in the implementation plan.

LITERATURE REVIEW

The literature search shows that the growth of partnering is directly related to the growth in claims and litigation regarding construction contracts throughout the nation (Kubal, 1994). In the late 1980s, the US Army Corps of Engineers (USACE) led the way for public agencies to begin using this new business practice as a means to avoid disputes and consequently reduce the ultimate cost of delivering public facilities. USACE's official program has largely been one of promoting the concept without any benchmark measurements or definitive performance measurement. The identification of quantitative measures of partnering benefits by public agencies has largely been avoided in favor of a less abstract assessment of qualitative benefits, and analyses of those few attempts to quantify this information is fraught with pitfalls. One of those pitfalls involves the collection, and more importantly, interpretation of statistics regarding partnering. In USACE, there was a tendency to credit partnering for project successes even when there was no tangible evidence of any improvement over the status quo (Gransberg and Ellicott, 1996). This was caused by the intense personal investment public project managers and contractors make during partnering sessions. There is no doubt that enhanced communication greatly improves a project's management/dispute resolution environment.

Most serious studies of the process have failed to identify significant benefits that can be directly attributed to partnering. The Arizona Department of Transportation (ADOT) has reported significant benefits from partnering using a study which found that partnered projects had 2% less cost growth than non-partnered projects (Chapin, 1994). But the method for computing these values seems to be quite arbitrary due to the way they seem to credit this 2% savings on all partnered projects contract price without regard to actual cost growth on each project. This same problem is rather well illustrated by a study done at the University of Texas (Grajek, 1995) where the author found that "…partnering (on 65 TxDOT projects) is not having a statistically significant impact on cost change, change order cost or net change cost." The same study found that partnered projects finished an average of 13.73% ahead of schedule as compared to non-

partnered projects that only finished 9.68% ahead of schedule. The author goes on to equate the value of early completion to the value of liquidated damages as a method to quantify the benefit of partnering. While this appears to show some impact, the fact that most projects finish ahead of the contract completion date indicates that the Department is being conservative in establishing those dates and the study is fundamentally flawed in assuming the value of finishing is equal to the cost of finishing late. While there is nothing fundamentally wrong with the TxDOT's policy for setting contract completion dates, it makes interpretation of actual performance data difficult with regard to schedule. A study conducted in 1994 of Ohio Department of Transportation (ODOT) projects cited many of the same difficulties in obtaining data (Chapin, 1994). This study based many of its recommendations on questionnaires distributed to ODOT and contractor field personnel. One of the study's prime recommendations is that only complex projects that exceed $5 million be formally partnered.

USACE found that partnering is most valuable on projects with tight schedules, and techniques such as issue escalation and open communication tend to enhance the efficiency of critical decision making. This allows the contractor the maximum amount of time to react to scope changes and still retain satisfactory progress. Change order time extensions are much more important to a contractor on a project with a tight schedule than on one that has greater schedule flexibility (Kubal, 1994). Thus, the contractor will be more liable to formalize a dispute over a time extension on the former than on the latter (Kane, 1992). This fact further blurs the validity of the apparent schedule improvement on partnered TxDOT projects. The other problem with past studies involves the small relative sample size available to past researchers. This springs from the fact that these studies were initiated at times when the use of partnering was relatively new, and there were comparatively few projects completed to analyze. To avoid statistical insignificance, this study sampled over 200 partnered and 200 non-partnered projects over a five-year period of time. The inferences made from analysis of the reduced data should be definitive.

The above discussion is not meant to cast doubts on the validity of the partnering process, but rather to indicate the importance of understanding the dynamics of the process that produces the contract performance data. Studies done on USACE and Naval Facilities Command (NAVFAC) projects confined themselves to competitively bid, firm fixed price projects (Pina, 1993, Schmader, 1994, and Weston and Gibson, 1993). Since the date of those studies, Best Value selection has been implemented on a broad scale by USACE and to a limited degree by NAVFAC. Best Value selection removes the requirement to award to the low bidder and has changed the dynamic under which partnering was developed in the Federal government (Ellicott and Gransberg, 1996). This approach shows much promise.

ANALYSIS RESULTS

Survey 1: Partnering Survey to States and Other Organizations

In the survey sent to states and other organizations, there were twenty-six responses. Many responses to Partnering were positive ones. Of the responses received, approximately 96 percent of the organizations said that they have partnered before. About 88 percent indicated that partnering improved the project in some way. Out of those who indicated improvement, about 52 percent said that it increased communication.

Initially, the team hoped to be able to directly measure partnering related benefits based on project performance data by using formulas found in other states or public agencies and then modified to fit the TxDOT environment. But no such formulas were found, and a direct measurement was too complex and abstract. Historical records were analyzed and databases developed which provided a basis for quantifying selected parameters. These were analyzed for possible indicators of a project's potential to benefit from formal partnering.

The survey resulted in the lack of responses regarding details of other agencies' methods to quantify or benchmark their partnering effort. With the possible exception of maintaining records of claims and project completion data, there appears to be no effort underway in the nation to quantify this type of benefit. Contacts with other agencies have led to comments that this effort is "too nebulous and of little value." Only two states, Arizona and Kansas, provided evidence that they were measuring partnering benefits, but unfortunately neither of them were willing to share their method of measurement.

In fact, no reliable method for providing a metric to measure partnering benefits has been found. We hypothesize that partnering is really a change in business behavior rather than the introduction of a technical innovation such as A+B bidding. Because partnering has no relationship to the technical aspects of the project, it is difficult to find substantiated improvements in project performance through traditional measures. In fact, it can be argued that project performance success is more influenced by the quality of the design, the environment in which construction must take place, and the technical abilities of both the owner and the builder than on the quality of the relationship inherent to the contract. Most quantified partnering "benefits" seem to be computed by determining the historical cost of contract problems such as claims and then imputing that cost as a benefit accrued by a partnered project if it is completed without a significant contract problem. For example, if the historical cost of construction claims in an agency was $100,000 per contract, then using this philosophy would impute a $100,000 "savings" for every partnered project which is completed without a construction claim. The fallacy of this approach is that it neglects the fact that most non-partnered contracts are also completed without a claim and it is blind to the statistical skewing of contract claims cost by the result of one multimillion dollar claim on agency's total program.

Another common attempt to quantify partnering benefits is to track agency supervision and administration costs on partnered projects and compare them to non-partnered projects. This method fails the common sense test because early in an agency's partnering program it tends to only partner large complex projects which, by nature, will have a lower than average supervision and administration cost per contract dollar than the average non-partnered project. It is concluded that there is no reliable medium in use to measure partnering benefits. Any attempt to do was relegated to come from the analysis of the data collected by this study.

The focus turned to evaluate the impact of past Partnering efforts. The data collection started with identifying 204 completed Partnering projects, then proceeded with identifying the same number of non-partnered from a time period that did not overlap the date ranges of the partnered projects. Twenty different data points such as contract completion date, original contract amount, and the number of change orders were collected on each project. All of the data was combined into one single database indexed to any of three data fields: the research team's project

identification number, TxDOT's project number, and a control number. This database contained 408 completed projects worth $2.1 billion.

In addition to the quantitative project performance data, surveys of both TxDOT field personal and contractors was conducted. The purposes of the survey were to assess attitudes toward the TxDOT Partnering program and identify factors that could lead to developing criteria for selecting a type of partnering (formal/informal). The last comparable measurement of the TxDOT program was accomplished in January 1995 as part of the research on a project by a graduate student at the University of Texas (Grajek, 1995). That survey was reviewed and, where appropriate, the same questions were repeated in the survey developed by the Texas Tech researchers particularly those assessing attitude toward the various aspects of the TxDOT Partnering effort. This approach allows TxDOT to use Grajek's report (1995) as a baseline for comparison with the latest survey results. A quasi-sampling approach was selected in which ten surveys were sent to every TxDOT district engineer for random distribution to field personnel. Of the 250 surveys distributed, 184 were completed and returned for a 74% response rate. A similar survey was also developed and submitted to a sample of general contractors who have completed partnered-TxDOT projects. Of the 238 surveys mailed to contractors, 68 were completed for a 29% response rate.

Survey 2: Formal Partnering Attitude Assessment and Analysis

In assessing Partnering attitudes of both TxDOT and the general contractor (GC) personnel, the focus in both surveys was to measure experience or maturation levels in the formal Partnering process. The general contractor questionnaire also asked for Partnering experience in non-TxDOT projects. While only 24% of the TxDOT respondents had participated in more than four partnered projects, the general contractor level was much higher at 43% for TxDOT partnered projects and 53% for non-TxDOT partnered projects. However, the maturation level for both groups for two or more TxDOT partnered projects was nearly the same level (TxDOT = 73% and general contractor = 81%). When compared to the Grajek (3) baseline data of 1995, which showed about 50 percent experience level for Partnering, experience has gained about 30 percent in both groups. The result strengthens the credibility of the survey by showing both groups are quite experienced with Partnering and can be expected to provide cogent information based on actual experience.

Question 6 of the survey asked the respondents to rate how Partnering may have affected their work relationships. Only TxDOT, General Contractor, and subcontractor responses are summarized in *Table 1*. The lower trend continues for subcontractors and may indicate as concluded in the baseline study that the partnering process still may not be filtering down below the owner/GC relationship. The 19% decrease in the GC's percentage as affecting their working relationship with TxDOT may show that as GCs become more experienced with Partnering, their expectations for quality of relationship rise. When the relationship does not improve as compared to the last partnered project, the GCs respond in a less positive manner. This also indicates there is probably an effective ceiling on partnering's ability to create a good working relationship.

Table 1. Partnering's Impact on Working Relationships (Combined Responses for "Somewhat Better" and Much Better")

Affected Working Relationships With….	TxDOT Survey	General Contractor Survey	Grajek Baseline Study (3) TxDOT/ G.C.
TxDOT	-	67%	86%
General Contractor	71%	-	67%
Subcontractors	37%	42%	46%

Question 14 on the general contractor questionnaire asked the respondents to rank the subjective measures of the Partnering process with 1 being the highest ranking. Table 2 summarizes the results and compares them to the baseline study (question 13). Important changes to note that occurred from the baseline study are in public satisfaction and stronger relationships. Again, perhaps the increased maturation levels of all participants have affected the rearrangements in benefit importance. Certainly the contractors see a greater benefit to TxDOT's satisfaction than TxDOT perceives to others.

Table 2. Qualitative Benefits of Partnering

Partnering Benefit	TxDOT	General Contractor	Grajek Baseline Study (3) TxDOT/G. C.
Better Communication	1	1	1/1
Better Teamwork	3	4	2/2
Increased Trust	5	5	3/3
Stronger Relationships	7	6	4/4
TxDOT Satisfaction	2	2	5/5
Contractor Satisfaction	6	3	6/6
Public Satisfaction	4	5	7/7

Question 15 on the general contractor questionnaire asked the respondents to rate the project teams developing a process for resolving disagreements. Table 3 summarizes the responses. The baseline study did not have this question in the survey. It appears from the data that the general contractors have a greater expectation for resolution of disagreements.

Table 3. Developing a Process for Resolving Disagreements

Response	TxDOT	General Contractor
Always	34%	35%
Most Times	37%	55%
Sometimes	24%	8%
Never	5%	2%

Question 16 on the general contractor questionnaire and question 18 on the TxDOT questionnaire asked the respondents to rate the project teams attitude that it was empowered to make the decisions it needed to make to complete the project. The baseline study didn't have this question in the survey. The results are shown in table 4. It appears from the data shown in the table that the general contractors perceive a greater authority to make decisions. The difference could be attributable to the organizational structure and culture of each group. The general contractor appears to be organized for more decentralized "field" decision-making authority than TxDOT.

Table 4. Empowered to Make Decisions

Response	TxDOT	General Contractor
Always	14%	15%
Most Times	47%	64%
Sometimes	32%	18%
Never	7%	3%

Question 18 on the general contractor questionnaire and question 21 on the TxDOT questionnaire asked the respondents to rate Partnering as it affects quality. The baseline study did not have this question in its survey. Table 5 illustrates the responses to this important question. A 22% difference between TxDOT and the General Contractor responses on "agreeing that the quality" may warrant further analysis to ascertain why there is a significant difference in perception. However, as the contractors are in a better position to assess actual project quality, the results are very encouraging.

Table 5. Overall Partnered Projects Improve Quality

Response	TxDOT	General Contractor
Agree	60%	82%
Disagree	40%	18%

Question 19 on the general contractor questionnaire and question 22 on the TxDOT questionnaire asked the respondents to rate Partnering as it affects safety and health. The baseline study did have this question in the survey. The results are shown in table 6. A 17% difference between TxDOT and General Contractors on "agreeing that Partnering improves safety and health" may also warrant further analysis to understand the significant difference in perception and again, the contractors perspective provides for an optimistic result..

Table 6. Overall Partnered Projects Improve Safety and Health

Response	TxDOT	General Contractor
Agree	64%	81%
Disagree	36%	19%

With respect to survey perceptions by TxDOT and General Contractor personnel, the most interesting finding is that 60% of TxDOT personnel and 82% of General Contractor personnel believe that Partnering improves the quality of the final project. As the contractors are in a better position to see just how much quality is built to the project, this is a significant finding. It can also be determined that the TxDOT Partnering program is well supported by both parties to the construction contract. Thus, it appears that both parties believe that investing in a Partnering process at the start of a new project greatly enhances the probability of success. To confirm this belief, a quantitative analysis must demonstrate that the performance of partnered projects exceed that of non-partnered projects.

Formal Vs Informal Partnering Survey

One of the primary objectives of this project was to develop a management tool whose purpose is to provide guidance to project managers responsible for determining the type of Partnering to use: informal or formal. A survey of both TxDOT field personnel and contractors was conducted. The purpose of the survey was to collect information from TxDOT districts and general contractors regarding attitudes toward formal and informal Partnering in order to determine parameters in which formal or informal Partnering would be appropriate. The same survey was developed and distributed to both TxDOT and General Contractor personnel. Questionnaires were sent to each of the ten districts. Of the 250 questionnaires sent, 190 were completed and returned for a 76% response rate. The same questionnaires were submitted to a sample of general contractors who have completed partnered-TxDOT projects. Of the 234 surveys mailed to contractors, 43 were completed for a 19 % response rate, notably less than the response rate for the internal TxDOT survey. One of the reasons for the low response rate in general contractor response was surveys returned to researchers by the postal service as undeliverable with no forwarding address provided. This could have been due to the high attrition rate in the general contractor business. However, a wide range of the specialists participated in the survey. The number of respondents and their experience in partnered projects are shown in *Tables 7 and 8*.

Table 7. The Respondents from TxDOT and Their Experience in Partnered Projects

Organization	TxDOT			
Job Title	Respondents		Experience in Partnered Projects	
	Number	Percent	Formal	Informal
Inspector	15	7.7	3.26	6.0
Chief Inspector	41	21.2	1.65	2.63
Project Engineer	14	7.3	13.4	17.5
Area Engineer	50	25.9	0.48	0.62
Construction Engineer	15	7.8	2.66	4.3
District Engineer	5	2.6	3	5
Design Engineer	4	2	3	5
Field Engineer	1	0.06	3	5
Lab Personnel	8	4	4	7.5
Others	54	27.9	-	-

Table 8. The Respondents from General Contractor and Their Experience in Partnered Projects

Organization	General Contractor			
Job Title	Respondents		Average Experience in Partnered Projects	
	Number	Percent	Formal	Informal
Superintendent	1	2.3	3	4
Project Manager	3	7.0	2	4
Area Manager	6	14.0	0.5	0.66
Vice President	19	44.0	7.7	7.1
President	6	14.0	2.0	2.3
Admin Stuff	1	2.3	0	0
Sub-Contractor	1	2.3	2	4
Mtrl./Equip. Supply	2	4.6	1	1
Others	4	9.3	1	1.75

The average experience dealing with partnered projects of those subgroups was as follows.

Table 9. Experience in Partnered Projects

Subgroup	Average Number of Partnered Projects	
	Formal	Informal
TxDOT Area Engineers	0.48	0.62
TxDOT Project Engineers	13.4	17.5
Contractor Vice-Presidents	7.7	7.1
Contractor Area Managers	0.5	0.66

Survey 3: Formal and Informal Survey Data Analysis

In assessing formal Partnering versus informal Partnering, attitudes of both TxDOT and general contractor personnel, the focus in the survey was to provide guidance to project managers responsible for determining whether to use informal or formal Partnering.

Question 4 on the questionnaire asked the respondents to indicate a dollar value on which to base a threshold for initiating formal Partnering. About 50% of TxDOT respondents have accepted threshold range of $5 – $15 million for initiating formal Partnering. Construction engineers (100%) and chief inspectors (73%) approved that range. However, a majority of area engineers (90%) designate the appropriate threshold to be $1 – $5 million. The most frequent opinion among General Contractors (47%) is that threshold for formal partnered projects should be $5 – $15 million. Presidents (63%) and vice-presidents (65%) of the companies support this threshold. But more than 65% of area managers designate that criterion at range $1 – $5 million. While threshold variations exists among TxDOT and General Contractor personnel by job title, the responses for this question indicate a majority by all of the above job titles as supporting the use of a one million dollar and above threshold value for initiating formal Partnering.

Question 5 on the questionnaire asked the respondents if projects involving multiple contracts should use formal Partnering. For projects that integrate multiple contracts, formal Partnering is recommended by 56.7% of TxDOT respondents. Among them, the chief inspectors (80%) and construction engineers (73.3%) are the strongest proponents of the criterion. Only 50% of project engineers adopted the criterion. For General Ccontractors, 58% accepted the criterion. It is interesting to note that 100% of vice presidents agree or strongly agree while all presidents are neutral, and 100% of area managers disagree or strongly disagree to accept that criterion. TxDOT and General Contractors are overall in the majority as accepting this criterion.

Question 6 on the questionnaire asked the respondents if projects involving unique characteristics and concerns should use formal Partnering. In general, TxDOT respondents agree (46%) and strongly agree (18.6%) that formal Partnering should be utilized because of unique characteristics and concerns of a project. Area engineers (83%) and chief inspectors (75%) firmly support this criterion. However, 72% of project engineers are neutral or disagree to assume the factor in question as the criterion for formal Partnering. Vice-presidents of contractor companies adhere to this (82%), whereas all of area managers do not buy this criterion. Overall, a majority of TxDOT and General Contractors agreed or strongly agreed with this criterion.

Question 7 on the questionnaire asked the respondents if projects involving public impact should use formal Partnering. The factor, impacting of the public during construction, is not approved for initiation of formal Partnering. Only 34% of TxDOT respondents and 23.7% of General contractors assumed the criterion. The level of disapproval is 39% of TxDOT respondents and 38% of general contractors. Nevertheless, area engineers of TxDOT (56%) and Vice-presidents of General contractors accepted, in majority, the necessity of this parameter.

Question 8 “An inability to meet the schedule will have negative consequences, and I should use formal partnering” was approved by 49.1% of TxDOT respondents and 39% of general contractor representatives. The level of disapproval is 25% among TxDOT and 32.5% of General contractors and therefore indicates that the criterion can be considered as desirable. Two groups of respondents – TxDOT area engineers (76%) and general contractor vice-presidents (89%) overwhelmingly approved this criterion.

For Question 9 “There are several parties involved in the project, and I should use formal partnering.”, the survey showed that less than 50% of TxDOT specialists (48%) and General contractors (39%) consider formal Partnering a necessity if several parties are involved in the project. It is concluded that, in general, the respondents are inclined to the criteria because only 29% of TxDOT specialists are against and 23% are neutral answering this question. In addition, the leading groups of TxDOT respondents: area engineers (64%), chief inspectors (55%), and construction engineers (53%) agreed on the criterion.

For Question 10 “TxDOT must closely coordinate with other parties, and I should use formal partnering” TxDOT respondents are not unanimous regarding the requirement to closely coordinate with other parties as a condition for formal Partnering. Generally, TxDOT specialists (47%) and General contractors (37%) supported this condition for initiation of formal Partnering. Three groups of TxDOT respondents expressed a high interest in the criterion: area engineers (66%), inspectors (86%), and construction engineers (53%). Of General Contractors, vice presidents approved the criterion at 78%.

For Question 11 “The project will require close coordination among other divisions within TxDOT, and I should use formal partnering”, the requirement of close coordination among TxDOT’s divisions as a factor for initiating formal Partnering is not approved by the majority of TxDOT specialists. Of them 67% are neutral or disapproved this criterion. One respondent group - vice-presidents of General contractors – voted in the favor of the criterion in question (65%).

For Question 12 “The finished product will be passed onto another governmental entity for operations and maintenance, and I should use formal partnering”, more of the respondents disagree (33.7%) than agree (29.6%) on the idea that transferring the finished product to another governmental entity should be a decisive factor for using formal Partnering. All respondent groups agreed on it.

For Question 13 “The product user (customer) has little or no experience with TxDOT, and I should use formal partnering” a majority of respondents concluded that formal Partnering is desirable if the product user has little or no experience with TxDOT. In general, 53.5% of all TxDOT respondents and 53.4% of general contractors support or strongly support this criterion. The majority of vice-presidents (94%) and area engineers accepted this criterion; although, all general contractors’ presidents are neutral. Rating of approval is 46% among construction engineers.

Question 14 on the questionnaire asked the respondents if projects that involve contractor’s project personnel who have little or no experience with formal Partnering should use formal Partnering. This criterion, experience of contractor’s project personnel with formal Partnering, collected almost the same number of supporters (38.9%) and opponents (39.3%) among TxDOT respondents (the remaining % neutral). The respective numbers among general contractors are 41.86% and 44%. The most representative subgroups of the respondents approved this criterion at the following levels: area engineers (50%), vice-presidents (94.7%). It appears from the overall percentages that support for use of this criterion is inconclusive.

Question 15 on the questionnaire asked the respondents if projects that involve TxDOT project personnel who have little or no experience with formal Partnering should use formal Partnering. This criterion also collected almost the same numbers of supporters and opponents in both of groups. TxDOT and the General Contractor respondents had 36% supporters and 42% opponents and 41% supporters and 42% opponents, respectively. Again, it appears from the overall percentages that support for use of this criterion is inconclusive.

The statistical analysis of response frequencies for the questions demonstrated that the experimental data fit the normal distribution with acceptable Chi-Square Probability > 0.1 (Table 11). It can be concluded that in most cases, the frequencies of the answers were distributed symmetrically. Among the subgroups of the respondents, area engineers of TxDOT and vice-presidents of general contractors were the active proponents of the majority of criteria offered by the survey as factors for formal Partnering initiation. Respectively, TxDOT project engineers and general contractor area managers demonstrated the most conservative approach answering survey questions.

Table 10. Chi-Square Probability > 0.1

Question	4	5	6	7	8	9	10	11	12	13	14	15
TxDOT - Chi-Square Probability	0.79	0.67	0.64	0.76	0.56	0.61	0.56	0.73	0.68	0.68	0.89	0.54
General Contractors-Chi-Square Probability	0.92	0.60	0.38	0.72	0.74	0.89	0.71	0.71	0.97	0.89	0.70	0.78

The second survey analysis indicates that in selecting formal Partnering the following criteria merit consideration.

- If the dollar value of the contract exceeds $5 million
- If the project involves multiple contracts
- An inability to meet negative consequences
- Unique characteristics and concerns
- If the product user has little or no experience with TxDOT.

TxDOT Project Database

TxDOT projects were sorted to match the format of the other two studies found in the literature search. This was done to find out if the trends discovered in the Grajek study continued, and with the Chapin study to see how TxDOT's performance compared to another state's DOT. Comparison of this study's findings with that of Chapin(1994) and Grajek(1995) are shown in Table 11. The other two studies' findings are supported by this study because the sample size was large enough to add statistical significance to the findings and the same trends appear in all three studies.

A statistically significant sample size for both partnered projects and non-partnered projects was determined. With this number, projects were randomly selected from among the pool of projects. Standard statistical measurements were used to provide a comparative analysis. Specific performance parameters such as Cost Growth, Average Percent Increase Per Change Order, Average Order Changes Per Project, Time Growth and Liquidated Damages as a Percent of Total Cost were also computed. Table 11 is a comparison of this study's results with past studies on the same project.

Table 11. Comparison to Previous Results with This Study's Results

MEAN	TxDOT 95 PT	TxDOT 96 PT	ODOT 94 PT	TxDOT 95 NP	TxDOT 96 NP	ODOT 94 NP
Number of Projects	54	204	20	107	204	123
Cost Change (%)	4.12	2.93	1.00	4.51	3.70	4.03
Change Order Cost (%)	3.67	0.19	0.99	4.19	0.38	0.03
Total Change Orders (#)	11.69	16.00	*	12.24	10.00	*
Duration Change (%)	-13.73	-4.70	*	-9.68	10.04	*
Liquid Damage Cost (%)	0.080	0.070	*	0.020	0.210	*
Claims Cost (%)	0.000	0.330	*	0.013	0.610	*
Award Price ($)	4,050,425	4,925,201	2,966,150	4,502,484	10,669,634	3,383,195

Note: TxDOT 95 = Grajek, 1995; TxDOT 96 = This study; ODOT 94 = Chapin, 1994

TxDOT has reduced the mean cost growth of partnered projects by 2% since the Grajek study. This study has also shown a much greater difference between partnered project cost growth and non-partnered project cost growth. Grajek reported about a 0.5% difference in cost growth between partnered and non-partnered projects finding the partnered projects to be slightly more efficient than the non-partnered projects. This study finds a 1.8% difference in cost growth between partnered and non-partnered projects which is a much more significant finding. Other factors may have contributed to the difference such as better designs, scheduling techniques, and dispute resolution; however, partnering is the only major factor that is not the same between samples. The Chapin study of Ohio DOT projects reported a 3.0% difference in cost growth.

Also, the mean change order cost percentage was found to be much lower in this study than either of the other two studies. TxDOT did show an increase in the mean number of change orders. From the amount found by Grajek this shows that TxDOT field personnel may be more willing to write change orders, and this could be the result of them being more willing to consider contractor-initiated change orders.

In looking at time growth, Grajek reported a decrease in construction time for both types of projects with the partnered projects outperfoming the non-partnered projects by 4%. According to the Grajek study this was not a big enough difference to say that partnering had a definite impact. This study found an increase in mean construction time for the nonpartnered projects, and the partnered projects outperformed the non-partnered projects by 14.74%.

In looking at the overall performance of partnered projects versus non-partnered projects, partnered projects out performed non-partnered projects in the following categories:

- Cost growth
- Time growth
- Mean change order cost
- Total number of claims
- Total amount of claims
- Total number of disputes
- Total amount of disputes

The only category that was contrary to this was in the total number of change orders. Although partnered projects had 38% more change orders, the total cost of those change orders was 67% less than non-partnered projects. The statistical breakdown of project parameters by "award price" range and "total population" is shown in Table 12.

Table 12. Statistical Breakdown of Project Parameters by Award Range and Total Population

Award Price Range	S0-$5M		$5M-$40M		$0-$40M	
Project Parameter	PT	NP	PT	NP	PT	NP
Number of Projects	146	146	58	58	204	204
Award Price	$2,170,135	$1,055,024	$11,860,368	$14,789,745	$4,925,201	$4,959,994
Cost Growth as % of Total Cost	5.22	2.39	1.87	3.94	2.93	3.70
Number of Change Orders	11	6	28	29	16	10
Avg Cost Growth per Change Order	$10,485	$9,309	$7,946	$21,032	$9,198	$18,713
Avg % Cost Growth per Change Order	0.48	0.88	0.07	0.14	0.19	0.38

As a result of these studies, we can conclude that Partnering has a distinctly positive performance for projects over $5 million. The average partnered project finished 4.7% earlier than originally planned and the average non-partnered finished 10.04% later than originally planned. For the projects between the $1 million to $5 million range, there are no costs associated with disputes and claims on partnered projects and their claim costs are lower in other ranges as well.

Table 13. Statistical Breakdown of Project Parameters by Award Price Range

Award Price Range	$0-$1 M		$1M-$5M	
Parameter	**PT**	**NP**	**PT**	**NP**
Number of Projects	35	100	110	46
Award Price	667,572	429,912	2,643,916	2,413,961
Cost Growth as % of Total Cost	12.47	-0.81	4.64	3.63
Number of Change Orders	8	2	12	7
Avg Cost Growth per Change Order	10,366	-2,324	10,511	12,850
Avg % Cost Growth per Change Order	1.55	-0.54	0.40	0.53
% of Projects with Deducts	4.41	24.02	12.75	7.84
Time Growth as % of Total Contract Days	2.84	-24.92	-3.16	15.76
% Additional Days Granted	20.25	4.71	7.90	17.86
% of Projects with LD's	1.47	6.86	10.29	4.41
LD % of Total Contract Days	1.58	1.99	1.51	3.15
LD Cost as % of Total Cost	0.21	0.09	0.11	0.25
Claims Cost (%) of Total Cost	12.93	5.46	0.11	0.15
Disputes Cost % of Total Cost	0.00	11.81	0.13	2.03

Award Price Range	$5M-$15M		$15M-$40M	
Parameter	**PT**	**NP**	**PT**	**NP**
Number of Projects	45	35	14	23
Award Price	8,557,678	8,552,594	22,240,253	24,281,065
Cost Growth as % of Total Cost	2.99	6.04	0.52	2.81
Number of Change Orders	23	21	45	38
Avg Cost Growth per Change Order	11,337	24,446	2,571	18,122
Avg % Cost Growth per Change Order	0.13	0.29	0.01	0.07
% of Projects with Deducts	4.90	2.45	0.49	1.47
Time Growth as % of Total Contract Days	-6.33	12.91	-8.64	23.71
% Additional Days Granted	6.63	11.72	8.99	13.80
% of Projects with LD's	1.96	6.37	0.00	5.88
LD % of Total Contract Days	0.91	4.64	0.00	10.21
LD Cost as % of Total Cost	0.07	0.29	0.00	0.64
Claims Cost (%) of Total Cost	0.00	1.07	0.00	0.08
Disputes Cost % of Total Cost	0.00	0.71	0.00	0.00

Table 14. Statistical Breakdown of Project Parameters by Award Price Range and Total Population

Award Price Range	$0-$5M		$5M-$40M		$0-$40M	
Project Parameter	PT	NP	PT	NP	PT	NP
Number of Projects	146	146	58	58	204	204
Award Price	$2,170,135	$1,055,024	$11,860,368	$14,789,745	$4,925,201	$4,959,994
Cost Growth as % of Total Cost	5.22	2.39	1.87	3.94	2.93	3.70
Number of Change Orders	11	6	28	29	16	10
Avg Cost Growth per Change Order	$10,485	$9,309	$7,946	$21,032	$9,198	$18,713
Avg % Cost Growth per Change Order	0.48	0.88	0.07	0.14	0.19	0.38
% of Projects with Deducts	17.16	31.86	5.39	3.92	23.53	36.27
Time Growth as % of Total Contract Days	-0.32	-9.16	-14.97	36.62	-4.70	10.04
% Additional Days Granted	28.15	22.57	15.62	25.52	8.32	12.49
% of Projects with LD's	11.76	11.27	1.96	12.25	21.08	23.53
LD % of Total Contract Days	3.09	5.14	0.91	14.85	5.04	14.56
LD Cost as % of Total Cost	0.32	0.34	0.07	0.93	0.07	0.21
Claims Cost % of Total Cost	13.04	5.61	0.00	1.15	0.33	0.61
Disputes Cost % of Total Cost	0.13	13.84	0.00	0.71	0.04	0.93

Partnering's Impact on Cost Growth

This parameter is the classic metric for project performance. Non-partnered projects outperformed partnered projects in the two lower award price ranges. The opposite was true in the two higher price ranges. This is an interesting result. It appears that the change in adversary relationships makes the owner's field personnel more willing to accept contractor-initiated change order requests. These would show has a higher percentage of contract value in less costly projects than in the larger projects. When the entire population is considered, partnered projects have a slightly less cost growth. This leads to the conclusion that implementing partnering generally improves cost growth performance with the greatest impact being felt in projects which are greater than $5 million.

Partnering's Impact on Change Orders

Change orders are the major source of cost growth. There were three parameters developed to evaluate partnering's effect on project change orders. The first concern that needs to be looked at is the feeling by field personnel that partnering makes the owner's representative more likely to accept contractor-initiated change requests. Analysis shows that partnered projects have more change orders than non-partnered projects. This would seem to confirm that suspicion. It should be noted that the researchers have no way of differentiating between contractor-initiated and other types of change orders. Next, we need to test the idea that the contractors "return the favor" by keeping change order costs down. Table 12 indicates that across the entire population mean partnered project change cost was roughly one half the average cost of the average non-partnered change order. This parameter was less for partnered projects in three out of the four project size groupings.

When viewed as a percentage of contact amount, the amount of each partnered change order is less than non-partnered change orders but the orders of magnitude are roughly the same for the top three groupings. The smallest projects stand out as an anomaly. Non-partnered change order values ended up as a net deduct while partnered change order cost was roughly the same per change order as in the larger projects. Perhaps, this is confirmation that implementing partnering creates an environment where TxDOT field personnel are more inclined to favorably consider contractor-initiated change requests.

If we measure contractor willingness to minimize overall project costs by looking at the percentage of projects with negative cost growth, ignoring the small projects, we find that for partnered projects in the $1 million to $5 million range the percentage of deducts is roughly twice that in non-partnered projects. This trend reverses itself in the largest projects. However, when you consider that the population of partnered projects in the middle range is 155 compared to only 14 in the highest range, you can dismiss that reversal as statistically insignificant . Therefore, we can conclude that partnering seems to create a desirable effect with regard to deducts.

Impact on Time Growth

The other objective measure of project performance is time growth. We have two parameters which are designed to provide trend information with regard to partnering. The first is mean percentage time growth. For the three largest size project groups, time growth was negative in partnered projects and positive in non-partnered projects. For the entire population, the average partnered project finished 4.7% earlier than originally planned and the average non-partnered finished 10.04% later than originally planned. The trend is reversed for the smallest projects, but again, the size of the partnered population makes it difficult to infer significance to that statistic. That is not the case for non-partnered projects with a population of 100 and a time growth of –25%. This result might be explained by the administrative process used to set contract completion criteria being too conservative. In other words, actual contractor performance consistently exceeds the expectations of those who establish contract completion criteria.

The second metric is the number of additional days granted expressed as a percentage of total days allowed. The parameter was meant to test the owner's willingness to grant time extensions as a result of a partnering relationship. The analysis shows that in the smallest three groupings this parameter shows a distinct willingness on the part of Department personnel to grant additional days on partnered projects.

Partnering's Impact of Liquidated Damages

This analysis may be the acid test for partnering. It is easy to grant accolades for innovative approaches that were tried on projects that went well. The real test of a partnering relationship comes from those projects that do not proceed according to plan. The data showed that there were liquidated damages assessed on partnered projects. That means that some partnered projects finished late in spite of the investment in team building and relationships. The percentage of partnered projects with LD's is less than non-partnered projects with LD's in all categories except the $1 million to $5 million range. This is notable in that that range contained over half the partnered projects and in that range there were over twice as many late partnered projects as non-partnered projects. However, if we redistribute the award price ranges as shown in Table 14, one can see that for partnered projects greater than $5 million only 2% have LD's compared to over 12% on non-partnered projects in the same category. Whereas, for those under $5 million the two types of projects are roughly equal. The $5 million break point seems to have some significance. Table 14 shows that partnered projects above $5 million outperform non-partnered projects in virtually every parameter.

Our analysis examined the impact of LD's with respect to the total project cost. In this case, while the $1 million to $5 million range had the largest percentage of partnered projects with LD's, the cost impact of those LD's was not as great as on the non-partnered projects which had a cost impact which was twice as great as the other. For the lowest cost group of projects, LD cost impact was greater than non-partnered and this can probably be explained by the fact that several days of LD's will constitute a proportionately larger percentage of a small contract than a large contract. Finally, when we look only at LD's in terms of time, we can see that partnered projects had a fewer number of LD days than non-partnered projects in all categories. Thus we can draw the conclusion that partnering does indeed work on projects with time problems by reducing the number of days that a project finishes late.

Partnering's Impact of Disputes and Claims

Remembering that disputes are issues that are settled at District-level or below and that Claims are issues that are settled above the District, studying the potential impact of partnering on these two parameters is extremely important. Our analysis shows that partnering seems to virtually eliminate the cost allocated to disputes and has the same effect on claims for projects greater than $1 million. The only significant costs that remain in these two parameters are for claims on projects, which are less than $1 million. When we look at Table 14, once again we see that for the $5 million to $40 million range, there are virtually no costs associated with disputes and claims on partnered projects. The total percentage of dispute and claims costs on non-partnered projects is relatively low. Whereas if we look to the lower half of the projects, we find that there are significant dispute and claims costs associated with both types of projects. This disparity is hard to explain. Perhaps, the magnitude of the issues encountered on the large projects was small enough in relation to the size of the project that both sides found it easier to settle these issues on the job site. On the other hand, an issue that might get lost in the financial noise of a large project may be large enough in relation to the size of the contract on a smaller project that it must be escalated to receive final settlement.

ANALYSIS OF PROJECT VARIANCE

To quantify project performance statistically, one must not only complete the comparative analysis detailed in the previous section, but one must also study the relative variance around the means established in the data analysis. In this setting, variance is a quantitative measure of TxDOT's control of final project outcomes. The outcomes of greatest importance are cost and time growth. Comparing relative variance between partnered and nonpartnered projects allows statistical inferences with regard to whether partnering enhances overall control of project performance outcomes. Smaller variance equals greater control. In this analysis we have selected the Coefficient of Variance (COV) as the best statistical measure for variability of project performance.

The projects analyzed were significantly different from each other in cost, volume and types of construction procedures. To suppress the negative influences of these factors, relative variables were introduced for statistical analysis. These variables were OC/FC (original contract cost/final cost) and OD/TD (original contract days/total days).

Use of the relative variables and comparison of their respective COV's revealed the fact that the variability of all partnered projects was smaller than the non-partnered projects. This variability is summarized in Table 15.

Table 15. Variability Comparison: Partnered and Non-partnered

Projects	Number of Projects	**COV for Variable**	
		OC/FC	OD/TD
Partnered	204	0.123	0.701
Non-partnered	204	1.254	0.99

An analysis of partnering effects based on forming cost-based subgroups did not demonstrate systematic statistical trends in all cases. However, for all the selected groups in partnered and non-partnered databases (below $1 million, $1 – 2 million, $4 – 10 million, > $10 million) , the COV for both relative predictors (OC/OF and OC/TD) was consistently smaller than that for all partnered and non-partnered projects (*Table 16*)

Table 16. COV Dollar Grouping: Partnered and Non-partnered

Relative Variable	OC/FC		OD/TD	
Projects with Original Cost ($Millions)	COV for Projects Partnered	COV for Projects Non - Partnered	COV for Projects Partnered	COV for Projects Non - Partnered
Below $1	0.146	1.55	0.59	0.708
$1 - 5	0.070	0.080	0.585	0.537
$5 - 10	0.050	0.090	0.454	0.403
> $10	0.254	0.059	0.438	0.395
All Projects	0.123	1.254	0.701	0.990

To further understand the variance of these projects, smaller groups of like projects were analyzed. Because the population in the data was quite diverse with respect to the kinds of construction that were actually conducted in each contract, the partnered and non-partnered projects were divided into two general groups. The contracts that only had one type of technical construction process are classified TYPE I. For example, a contract that involved only pavement

rehabilitation would be classified as a TYPE I project. All other projects that involved more than one technical construction process in one project are classified as TYPE II. For instance, if a pavement rehabilitation project also included a seal coat, this would be a TYPE II project.

Partnered TYPE I projects were further divided into two subgroups: Asphalt Concrete Paving (ACP) and Rehabilitation. These were the two types of technical construction process in data population that had the largest number of similar projects. Thus, a reasonably statistical analysis could be conducted. Similarly, Partnered TYPE II projects were also divided into two groups for the same reason: Grading and Planing. Non-partnered TYPE I projects were also divided into two dominant subgroups: Asphalt Concrete Paving and Seal Coat. Finally, Non-partnered TYPE II projects were separated into Grading and Widening. The coefficient of variance was calculated for each of these subgroups and is shown in Table 17.

Table 17. Coefficient of Variance (COV) Analysis

OD/TD

Non-partnered	COV	Partnered	COV
ALL-Non-partnered	0.99	ALL-Partnered	0.70
TYPE I All	0.80	TYPE I All	0.61
TYPE I -Seal Coat	0.66	TYPE I -ACP	0.44
TYPE I -ACP	0.52	TYPE I -Rehabilitation	0.31
TYPE II-all	0.87	TYPE II-all	0.72
TYPE II-grading	0.70	TYPE II-grading	0.71
TYPE II-widening	1.08	TYPE II-planing	0.23

OC/FC

Non-partnered	COV	Partnered	COV
ALL-Non-partnered	1.25	ALL-Partnered	0.12
TYPE I All	0.19	TYPE I All	0.11
TYPE I-Seal Coat	0.09	TYPE I-ACP	0.05
TYPE I-ACP	0.03	TYPE I-Rehabilitation	0.10
TYPE II-all	0.08	TYPE II-all	0.14
TYPE II-grading	0.07	TYPE II-grading	0.16
TYPE II-widening	0.07	TYPE II-planing	0.11

It should be noted that due to the great diversity of project types it is impossible to directly compare every partnered subgroup with its corresponding nonpartnered subgroup. However, direct comparison can be made for TYPE I ACP and TYPE II Grading. Table 17 shows that cost growth COV for partnered projects is significantly less than for nonpartered projects. All of the COV calculations result in partnered COV's that are less than nonpartered COV's.

The statistical analysis shows that the change in original cost of partnered projects is significantly less then the change in non-partnered projects. All of the calculations and the two main approaches result in the performance of partnered projects exceeding that of non-partnered projects. Therefore it can be inferred that instituting partnering reduces project performance variance. This means that TxDOT has greater control over both cost and time growth on partnered projects. In fact, across the entire population (Table 16: All Projects), it appears that partnered project cost growth is ten times less variable.

Regression Models

Stepwise and complete regression procedures were used for multiple regression analysis with the types and subgroups. The results of this analysis are presented in Appendix A. While interesting from an academic standpoint, they were judged to be of no practical predictive value. Therefore, details and discussion have been related to the appendix.

FINDINGS AND RECOMMENDATIONS

Analyzes of all data supports the following conclusions.

1. Partnering has become an institution in TxDOT. Awareness of the Partnering Program and its goals is wide spread and pervasive. The Office of Continuous Improvement is recognized as the subject matter expert for the organization.

2. Partnering is used in most public engineering/construction agencies throughout the nation. It is an accepted business practice for both government and industry. It is generally recognized as a means to improve communications, reduce adversarial business practices, and create a good environment in which to conduct business. It is believed to reduce contract disputes, claims, and litigation. However, the literature contains little documentation of this perception.

3. Partnering has potential to improve contractual relationships beyond the so-called traditional engineering design and construction contracts. It has been used as a mechanism to improve internal communications and relationships within various types of organizations.

4. The time and expense of the widespread use of formal partnering has led to the development of informal partnering practices to capture the best elements of the partnering movement without incurring the costs of a full blown partnering session. Informal partnering seems to be the rule rather than the exception.

With respect to the quantitative analysis, significant trends have been identified and the following conclusions made.

1. Partnered projects outperformed non-partnered projects in virtually every category if they were awarded at a price above $5 million.

2. Partnered projects have a slightly less cost growth when the entire population is considered.

3. Partnered projects have more change orders than non-partnered projects and this probably demonstrates an increased willingness by TxDOT field personnel to favorably consider contractor-initiated change requests.

4. Across the entire population the mean partnered project change order cost was roughly one half the average cost of the average non-partnered change order. Therefore, contractors are attempting to keep the cost of change orders down.

5. The idea that contractors are working to keep costs low is further reinforced by the trend which shows that partnering seems to create a desirable effect with regard to the number of projects with negative cost growth.

6. For the entire population, the average partnered project finished 4.7% earlier than originally planned and the average non-partnered finished 10.04% later than originally planned.

7. Partnered projects have a fewer number of liquidated damages (LD) days than non-partnered projects in all categories. So partnering seems to have a positive effect on projects with time problems by reducing the number of days that a project finishes late.

8. For the $5 million to $40 million range, there are no costs associated with disputes and claims on partnered projects.

With respect to the survey of perceptions by TxDOT and contractor personnel, the following following conclusions can be made.

1. The focus was to measure partnering experience and maturation levels in the formal partnering process. The general contractor question is also asked for partnering experience in non-TxDOT projects. While only 24% of the TxDOT respondents had participated in more than four partnered projects, the general contractor level was much higher: 43% for TxDOT and 53% for non-TxDOT partnered projects. However, the maturation level for both groups for two or more TxDOT partnered projects is nearly the same level (TxDOT=73% and General Contractor=81%). When compared to the Grajek baseline data of 1995 which showed about 50% experience level for two (2) or more partnered contracts for both groups, the maturation level for partnering experience has gained almost *30%* for both groups.

2. 60% of TxDOT personnel and 82% of contractor personnel believe that partnering improves the quality of the final project. As the contractors are in a better position to see just how much quality is built in to the project, this is a significant finding.

Finally, integrating the quantitative and subjective analyses, yields two important findings.

1. Partnering appears to have a distinctly positive performance impact on projects which are greater than $5 million. This statement is backed up by the survey of ODOT personnel and contractors who selected this level as the right level on which to invest the time and money to formally partner a project.

2. The presence of a partnering agreement seems to take the psychological pressure off the contractor as the TxDOT field people become more willing to grant contractor-initiated

change orders and additional days. The contractors seem to react favorably to this by keeping the cost of change orders down and by completing earlier than anticipated. They also believe that they produce a better quality project as a result of the presence of a partnering agreement.

IMPLEMENTATION PLAN

Approach

The results of this study have conclusively shown that Partnering has been institutionalized in the Texas Department of Transportation. Therefore, what remains to be done is to formalize the decision-making process in a manner that maximizes the benefits accrued by partnering without wasting precious resources by partnering all projects regardless of type. The implementation of the TxDOT Partnering Plus program in 1996 required that all projects be partnered. To do this, the Department separated partnering into two types: Formal Partnering and Informal Partnering. The difference was defined as follows.

> "Partnering can be formal, which requires a facilitated meeting, or informal, which requires a non-facilitated meeting between TxDOT and Contractor representatives who will work the project." (TxDOT Partnering Handbook, 1996).

This study found that informal partnering was the more popular of the two types. Commentary data reveals that this is because the focus seems to be project-oriented. This certainly makes sense because all the participants are directly involved in the project. In a formally partnered project, the facilitator generally is not involved in the project, and as a result of both that and the fact that the facilitator personally leads the workshop, the workshop will be more focused on the relationships. These facts lead to the first implementation recommendation. The Department should drop the terms "formal and informal partnering" and return to the pre-1996 policy of partnering those projects where the investment in relationship-building will accrue benefits. Informal Partnering should be replaced by inserting three facets of the typical partnering workshop to the preconstruction conference for those projects that will not be partnered. Those facets are listed below.

1. Potential project issues (sometimes called "Rocks in the Road")
2. Action plans to resolve these issues.
3. Development of an issue resolution/escalation ladder.

Doing so will further institutionalize the benefits of the partnering process ensuring that the three most beneficial facets of the partnering workshop will be retained for all projects without the need to specifically focus on relationship-building. Thus, the definition of a "partnered project" becomes one where the project's nature is such that investing the time to specifically focus on TxDOT-Contractor relationships is deemed to be worthwhile and will likely accrue benefits. Therefore, the remainder of this section is devoted to the development of a partnering decision-making process to assist Department management personnel in determining which projects have the greatest potential to benefit from the investment of time, money, and energy required to hold a partnering workshop. It should be noted at this point that for the remainder of this section the

term “partner” will be used to describe some type of facilitated meeting whose focus is on building a strong, positive relationship between TxDOT and its Contractor for the life of the project.

Partnering Model

The basis of this model is to leverage the information gained during the both the quantitative and qualitative analyses completed in this study. These analyses proved that implementing partnering on certain projects does indeed accrue benefits to the Department in terms of cost and time savings as well as the virtual elimination of claims and disputes costs. Additional, the statistical analysis showed that partnering reduced variability and gave the Department more control over partnered projects. Therefore, it is logical to use these facts to maximize the benefits of partnering by applying it to those projects whose inherent qualities make them most susceptible to partnering benefits.

Figure 1 is a flow chart designed to document the process of deciding whether to partner a specific project. It leads to a decision to either partner or cover the three partnering facets mentioned above in the preconstruction conference. Partnering is about relationships. Therefore, the first step is to determine if Department and Contractor personnel are working together for the first time. A contractor who may have done work for TxDOT in another area still needs to become familiar with the standards to be enforced on this specific project. In fact, it may be more important in this instance than for a contractor who is embarking of its first TxDOT project. Research Project 0-1787 “Seal Coat Constructability Review” found that there are large differences between Area Offices with regard to how a project as simple as seal coat are applied (Gransberg, et al, 1998) and that contractors often assume that project quality control requirements are uniform across the Department. This impacts the way they prepare their bid and could lead to a source of friction during project execution. Therefore, a new relationship creates a situation where investing in a partnering workshop is warranted in almost every case. Obviously, the level of effort expended on each project should be a function of its size and complexity.

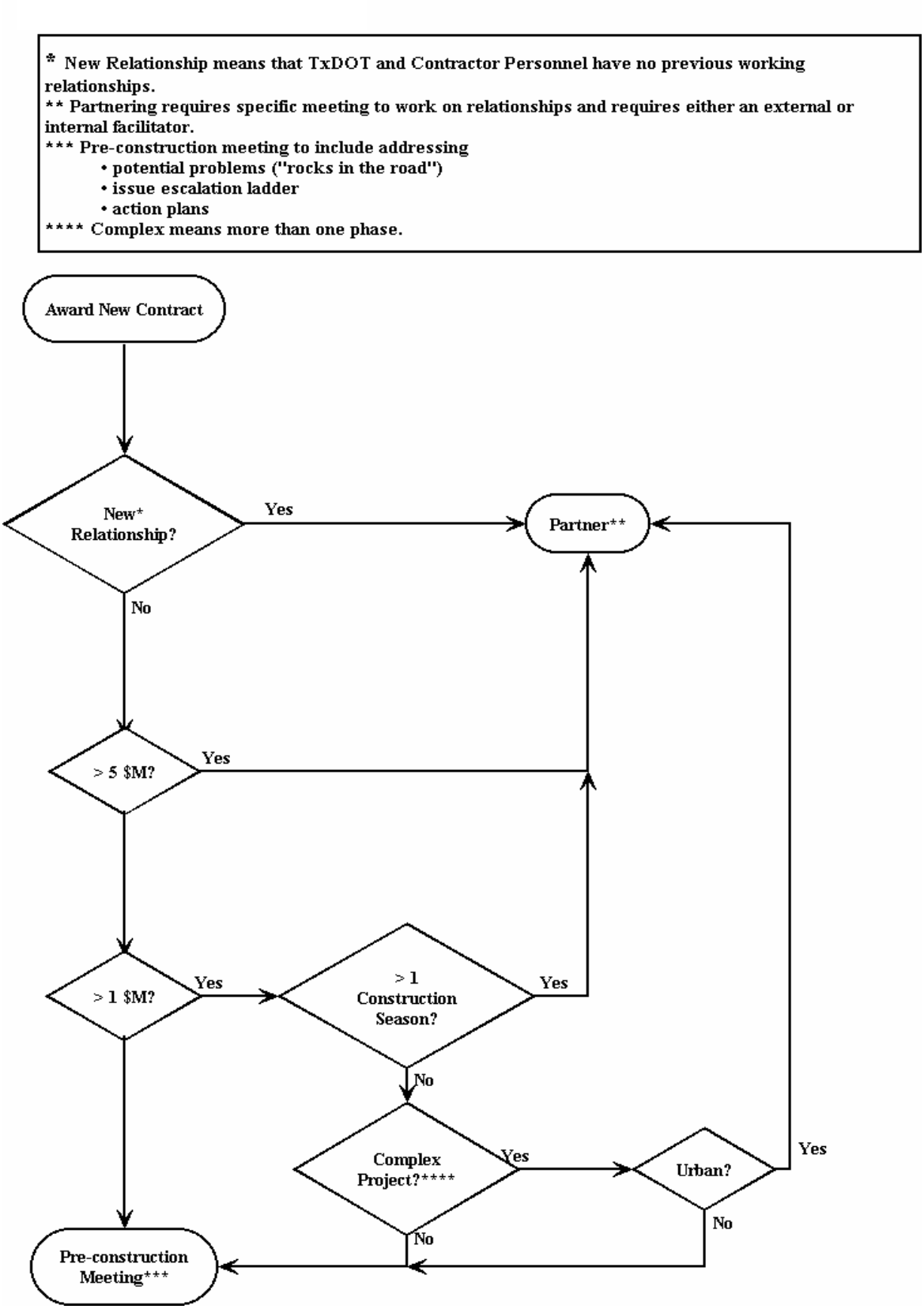

Figure 1. TxDOT Partnering Flowchart

The quantitative study showed conclusively that projects greater than $5 million directly benefit from partnering (Gransberg, et al, 1997). They accrue roughly 2% less cost growth, significantly less time growth, and no costs associated with claims and disputes. Even when they finish late, they have lower assessed liquidated damages and finish less late than nonpartnered projects. In this award price range, partnered projects outperformed nonpartnered projects in all categories. Therefore, it is prudent to partner all projects whose award price is greater than $5 million.

For those projects whose award price is less than $5 million but greater than $1 million, cost growth savings were not evident, but time growth savings were. In public transportation construction projects, user costs of construction can be very high. Total user construction cost is a function of the total length of a given project. These costs are minimized by completing projects as quickly as possible. The quantitative study showed an 18% time savings on partnered projects in this price range, and partnered projects finished approximately 3% early while nonpartnered project finished around 15% late. Therefore, remembering that user costs of construction were not considered in the cost savings analysis, it is logical to consider partnering projects in this price range as a means of accruing maximum time savings. Obviously, projects with a short duration will not accrue as much benefit as longer projects. Therefore, a benchmark must be established to separate the two types. Table 17 shows that the average duration for partnered projects in the subject price range is about 180 contact working days with a standard deviation of about 90. As a result, the logical break point would be for those projects that last longer than the average plus one standard deviation. In this case that would be 270 contract working days. So to attempt to make the decision uniform on a statewide basis, the contract duration break point will be defined as greater than one construction season. This permits flexibility to adjust to differing climatic conditions while retaining the salient reason for partnering projects in this price range. Obviously, the potential for problems due to construction delay will be greater for those projects that extend across more than one construction season.

Table 18. Contract Time for Projects Between $1 and $5 Million.

Nonpartnered Projects	Contract Working Days	**Partnered Projects**	Contract Working Days
Mean	193	Mean	177
Standard Deviation	117	Standard Deviation	91
Coefficient of Variance	0.606	Coefficient of Variance	0.516

Projects that are in the $1 to $5 million award price range but whose duration is less than one season are the next discussion topic. At this point, only the survey data gathered from TxDOT and Contractor personnel to help guide the decision-making process is used. Both groups cited project complexity as a reason to partner. This is application complexity will be defined by the number of construction phases required. A project is “complex” if it has more than one construction phase. Thus, this type of project will require closer coordination to successfully complete. This coordination is doubly important in an urban project where exposure to the traveling public is the highest and the potential for construction related congestion is almost certain. Therefore, the model leads to a decision to partner this type of project if it is both complex and located in an urban area.

To summarize the model, the following projects will be partnered.

1. Projects where a new business relationship exists.

2. Projects with an award price greater than $5 million.

3. Projects with an award price between $1 million and $5 million where:

    a. Project duration is greater than one construction season

    b. Project duration is less than one construction season but the project has more than one phase of construction and is located in an urban area.

All projects that do not fit in the above categories would not be partnered. However, project issues, action plans, and issue resolution/escalation would be covered as a mandatory agenda item in the preconstruction conference for all projects.

Specific Implementation Actions

It is recommended that the following actions be taken to implement the findings of this project.

1. Revise the Partnering Handbook to reflect the partnering decision-making model detailed in this section.

2. Change the appropriate policy documents regarding the preconstruction conference to reflect mandatory inclusion of project issues, action plans, and issue resolution/escalation as an agenda item in all preconstruction conferences.

3. Take the results of this study and include it in the Partnering Handbook as a mechanism to retain institutional knowledge on this subject. The results of this study furnish the hard factual evidence that Partnering does indeed accrue benefits on certain types of projects. Knowing these facts should facilitate acceptance of the new model by those skeptics that remain in both the Department and in Contractor organizations.

4. Update "Special Provision – Partnering Plus" to reflect that partnering is a facilitated meeting focused on relationship-building. Eliminate all references to informal partnering.