PREDICTING CONSTRUCTION COST GROWTH IN ODOT'S PAVING PROJECTS USING INFORMATION AVAILABLE AT THE BIDDING TIME

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CHAPTER I

INTRODUCTION

Background

Construction cost growth can be defined as the increase in cost of a project. More precisely, it can be defined as the difference between final project cost and the initial contract amount. Change in a project cost results usually in either an overrun or an underrun. It remains one of the most important issues for all of the parties involved in a construction project. It is the goal of engineers and contractors to estimate, as accurately as possible, the actual final cost of a project because no one wants to lose profit or divert money from other projects to cover additional costs due to overrun or prevent other projects from being funded in the case of an underrun. For this research, cost growth and cost change are considered to have the same meaning.

The change in a project cost, or cost growth, occurs due to several factors, some of which are related to each other. Determining the existence and influence of each of these factors in a project may lead to better control on construction cost and assist in identifying possible solutions to avoid the expected over/underrun.

Previous studies of project changes have been directed towards identifying the factors that cause cost growth. There is a need for a study to determine the relationship

between those factors and to develop a statistical model to predict the amount of cost over/underrun in construction projects based on the relative influence of those factors.

Purpose

The purpose of this study is to determine the factors related to cost growth in ODOT paving projects and to evaluate data from completed construction projects to study the influence of those factors. The relationship between the factors and the cost growth is observed and determined. A statistical model to predict the amount of cost overrun or underrun is developed based on those factors.

Objectives

The objectives of the research are to (1) Identify the factors that may lead to cost changes, or cost growth, in ODOT paving projects. (2) Rank different factors according to their influence and impact on the cost changes. (3) Develop a numerical model, based on statistical theories and concepts, that predicts the amount of cost growth in ODOT paving projects using information available at the bidding time and based on the existence and relative importance of the factors identified in (2) above.

Assumptions

The evaluation and analysis processes in this research are performed under several important assumptions. These assumptions are considered in order to use regression analysis and other statistical concepts and theories needed in the research to develop the mathematical model to predict the amount of cost growth. The assumptions are as follows:

- Cost factors included in the final prediction model are independent.
- No unusual values are observed during the regression analysis of cost factors.
- Values observed in different projects and included in the analysis are normally distributed.

Scope and Limitations

To achieve the purpose and objectives of the research, information regarding the cost factors which may have an impact on the construction costs was gathered. Then, factors which have an influence on the construction cost were ranked according to their degree of influence. Data were collected from numerous completed construction projects. All information gathered in this research was collected from various estimating, design, and construction databases within ODOT. Regression analysis was performed on the data to show changes in construction costs.

The research was conducted in several phases. The first phase involved development of two questionnaires designed to get feedback regarding the cost factors

and their ranking. These questionnaires were distributed among ODOT engineers and contractors.

The second phase of the research involved analysis of data obtained from the questionnaire to identify and rank the final list of cost factors.

The third phase of the research involved the process of collecting project information related to cost data and determining the existence of any cost factor from the previously obtained list.

The fourth phase of the research involved analysis of the data collected in the third phase. In this phase, a statistical model was developed to predict the amount of cost growth for paving projects based on the information available at the bidding time.

All data collected and analyzed in this research were obtained from a single source: Oklahoma Department of Transportation (ODOT) paving projects. Therefore, the model can only be applied to ODOT paving projects. The model is also limited to projects with contract amounts less than five million dollars. It should also be noted that some cost factors are strongly related to economic conditions which may vary considerably from time to time. The variation in the economic conditions from the time of collecting the data to the time of predicting a project's cost growth may lead to inaccurate results.

Definitions

"Cost Growth", "Cost Changes", and "Cost Over/Underrun" are considered, for the purpose of this research, to have the same meaning. They can be defined as the difference between the final project cost and the initial contract amount for a particular project.

"Contract" is an agreement between two or more parties to do a certain thing, which is legally enforceable. For the purpose of this research, all contracts are paving contracts.

"Owner" is the individual or organization for whom something is to be built or furnished under contract. For the purpose of this research, The Oklahoma Department of Transportation (ODOT) is the owner. It is the organization for which paving projects are to be built under contracts with paving contractors.

"Contractor" is the party who, for a stated price, supplies materials and performs construction services for the owner. For this research, it is the organization responsible for overall construction of paving projects, acting as general contractor or prime contractor.

"Project size" is to be defined as the cost in dollar amount of work involved in a project.

"Project location" is the county, one of seventy-seven counties in the State of Oklahoma, in which the project took place.

"Bid range" is the difference between the high and the low bids, in dollars.

"Money left on table", MLOT, is the difference between the low and the second low bids, in dollars.

"Contract difference" is the difference between ODOT estimate and the contract amount, in dollars.

"Bidding environment" is the number of projects let by ODOT during the month bids were opened.

"Timing of notice to proceed" is the period between contract award and notice to proceed, in calendar days.

Research Methodology

Steps involved in the research are outlined in Figure 1. The first step focused on determining the cost factors from previous studies. Previous studies indicated important factors that had impact on the cost changes in construction projects. These factors were refined, and only factors related to paving projects were considered.

The second step involved the addition of other factors to those previously found. Several discussion sessions and meetings were held with ODOT engineers and committee members in order to determine what other influencing factors could be added to the list.

Finalizing the list of cost factors was the focus of the third step in the research. Factors from the previous two steps were combined to form the final list of cost factors which was used in the following steps. Wording of the factors was carefully checked to ensure simple and clear words.

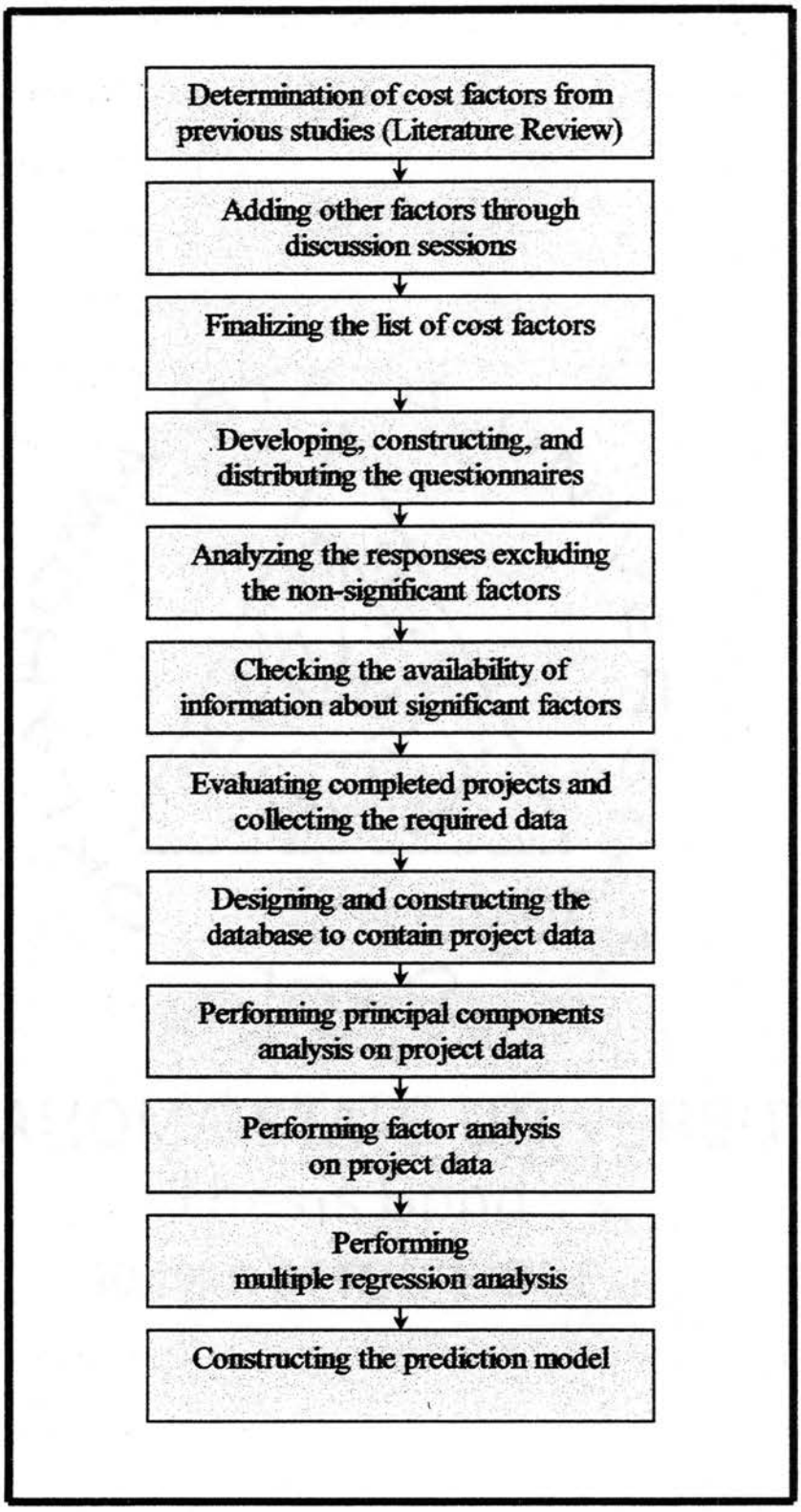


Figure 1 – Research Steps

The fourth step involved developing, constructing, and distributing the questionnaires. Two questionnaires, one for ODOT engineers and the other for ODOT prequalified contractors, were developed. The engineers' questionnaire contained factors related to engineers, whereas the contractors' questionnaire contained factors related to contractors. Factors found to be related to both engineers and contractors were added in both questionnaires. The questionnaires were mailed to engineers and contrctors and a deadline was established to return the responses to ensure that responses would be received within an acceptable period of time.

Analyzing the responses to the questionnaires was performed in the fifth step. Participants' responses were received and analyzed to evaluate those cost factors that were thought to have impact on the cost growth. According to the participants' point of view, significance of each factor was determined. In addition, simple calculations were performed on the responses to establish a severity index and a ranking for each factor contained in the questionnaires.

The sixth step involved checking the availability of information of the significant factors. After significant factors were determined, it was necessary to determine whether or not data related to those factors were available in ODOT files for the paving projects to be included in the analysis phase. Only factors with suitable available data were kept and considered as variables in the analysis procedures.

In the seventh step, files in the ODOT offices were searched to identify paving projects that met the established criteria. A total of 266 paving projects were selected for analysis in this research.

A database was designed and created in the eighth step. Tables, queries, and forms were designed and created within the database to make the process of entering and maintaining the project data easier and more convenient. Project data were stored in the database in a table format compatible with the Microsoft Excel Spreadsheet and the Statistical Analysis System (SAS) software. Therefore, no further transformation processes were needed to prepare the data for use in the analysis phase.

In the ninth step, a principal components analysis was performed on the collected data to check the collinearity among variables and the existence of outliers. Collinearity was observed among some of the variables which indicated that some variables were related to each other and therefore could not be used together as separate variables during the regression analysis. Thus, performing factor analysis on the variables was found to be necessary to group the related variables in factors that could be statistically evaluated in the regression analysis. Also, several outliers were observed and marked.

Factor analysis was performed in the tenth step. Related variables were grouped in principal factors and the number of variables was determined.

The eleventh step involved performing the multiple regression analysis. Principal factors that were determined in the factor analysis were used instead of individual variables. Categorical, non-numerical, variables were added to the principal factors forming the final set of variables used in the analysis process.

The predicting model was developed in the twelvth and last step. After a significance level was selected, several models containing different variables and having different R^2 values were developed. All variables were statistically significant at the

specified significance level. The model that had the highest possible R^2, highest practical significance, was selected to be the final prediction model.

Chapter Summaries

In chapter II, the literature search of previous studies relating to construction cost, cost and schedule growth, impacts of project changes, construction cost factors, and construction cost overrun is discussed.

The data collection procedures are described in Chapter III. The surveying process including questionnaires design and development is discussed. Collecting, entering, storing, processing, and preparing project data are also described. Demographics of the selected projects are also given to provide an overview of the projects involved in the research.

Data analysis techniques and statistics are described in Chapter IV. Analysis of the responses to the questionnaires, principal components analysis, factor analysis, and regression analysis are all discussed in this chapter.

The data analysis results are discussed in Chapter V. Implementation of the prediction model is also included.

Chapter VI provides a summary of findings, conclusions, and recommendations for further studies and research.

CHAPTER II

REVIEW OF LITERATURE

Introduction

Most of the publications related to project cost changes have been directed towards identifying the factors that cause or influence cost changes in projects that may lead to cost over/underrun. This chapter presents a summary of previous studies that have been conducted on cost changes and their impact on engineering and construction projects.

Impacts of Project Changes

In their research study to quantify the impact that project changes have on engineering and construction project performance, Ibbs and Allen (1995) defined change as any event which results in a modification of the original scope, execution time, or cost of work. Because change may occur throughout all phases of a project, their research focused on the quantitative impact that change has on the detailed design and construction phase of projects. It was found that project change has a tremendous effect on the financial performance of a construction project. Improper change management

was exhibited in the increased incidence of negative impacts exhibited by project cost overruns, claims, and disputes.

A study by Hester, Kuprenas, and Chang (1991) found that most owners and engineers assume routine changes in the work will affect only the work in the changed area. It was proven that the effects can extend well beyond that area. It was explained that numerous other studies found that scope changes in projects were the most frequent source of changes and the most serious in terms of cost and schedule impact. When citing the impact of changes, all of the studies noted the consequential impact on the cost/schedule of the project as a whole.

Suhanic (1980) provided some quantitative estimates for the impact of changes on cost and schedules in a very limited manner. Thomas (1985) studied highway construction programs and reported on selected claims over changes and costs/schedule overruns on these same projects. It was found that project changes had a direct effect on costs and schedules of construction projects, primarily cost/schedule overruns.

Research by Zeitoun (1992) found that high cost and schedule growth occurred primarily in the last quartile of the construction phase. No specific reasons were given or addressed in the research for having high project growth in the last quartile of construction, but it was believed that project change was among the major reasons. Project cost and schedule growth were accredited to project changes. For 71 of the fixed price projects included in the research, the average cumulative cost growth was 11.5% and the median cumulative cost growth was 8.6% at the end of the fourth quarter.

Cost and Schedule Growth during Construction

The study by Zeitoun identified several factors that are early warning signs of cost and/or schedule growth during construction. The cost growth in this study was based on the dollar amount of approved change orders during construction and did not include the cost of claims at the end of the project. The study addressed fixed price and cost reimbursable projects separately.

Preliminary Estimates of Construction Cost

A study by Hester, Kuprenas, and Chang (1991) indicated that the estimating method and the accuracy of project cost estimates could be major reasons for having cost changes. When an inaccurate original estimate prepared for a project is used and compared with the actual cost of that project, there will be a noticeable difference, which is referred to as a cost change.

Construction Cost Factors

A study by Charles and Andrew (1990) indicated that cost overruns in construction contracts include change orders and claims. Factors that influence the construction change order rates causing cost overruns were identified. Those factors were size of the project, the difference between the low bid and the estimate, the type of

construction, the level of competition, the quality of contract documents, the interpersonal relations within the project, and the policies of the contractor. It was discovered that a cost overrun rate of one to eleven percent is more likely to occur on larger projects than smaller ones. Contracts with an award amount less than the estimate were found more likely to have cost overrun rates above five percent.

Okpala and Aniekwu (1988) found that there are twenty variables that could cause cost overruns and delays, and seven others that could result in cost overruns without necessarily causing delay. It was discovered that high construction costs can be minimized by minimizing lapses in the management of human and material resources. Four major reasons for high construction costs were identified: (1) shortage of materials; (2) methods of financing and payment for completed works; (3) poor contract management; and (4) price fluctuation.

The research completed by Zeitoun focused on identifying factors that are known prior to the commencement of construction. The purpose was to provide early warning signs of project cost and schedule growth. Several early warning signs were identified. Those warning signs showed statistical correlation with the final project cost and schedule growth. For fixed price projects, the early warning signals were in the categories of money left on the table, number of bidders, execution format, and bid solicitation. It was mentioned that professionals in the construction industry can use these factors to effectively manage project changes and control costs. For cost reimbursable projects, the early warning signals were in the categories of primary driving factors, execution format, quality, and work distribution. Low cost and schedule growth were indicated when quality was the driving factor in the project.

Elinwa and Buba (1993) identified thirty-one factors as causing cost overruns and delays in construction projects. These factors were found to have some sort of influence on construction project cost and schedule. Of those factors, shortages and cost of materials, fluctuation in prices of materials, mode of financing and payment for completed works, poor contract management, and improper planning were found to be the major factors behind high construction costs.

Using Bid Data to Predict Construction Cost Overrun

A study by Farbarik (1994) was undertaken in an attempt to define which, if any, of the many factors encountered before construction can be used to predict increased construction costs. The research attempted to predict construction cost overruns using bid data. The study focused on what means the owner, whether public or private, can predict the cost of planned construction and how much reliance should be placed on conventional wisdom in this planning effort. This basic problem was broken down into several smaller problems including the accuracy and quality of the construction cost estimate, determining the amount of contingency funds that should be set aside to cover the cost of the changes, and determining the fundamental causes of the changes. It was identified in the study that of the information available at the time of bid, only the level of construction spending and the type of facility being constructed were found to have any significant statistical relationship to construction contract change order rates. It was concluded that the results of the analysis of the relationship of change order rates to other variables thought to affect or to be useful in predicting change order rates in construction

contracts were disappointing. Low correlation coefficients and inconsistent results were obtained during regression and chi square analyses. The results of several attempts to improve the results through the removal of outlier data and multiple regression analysis were mixed and unsatisfactory. A conclusion was reached that, based on the data presented in the study, there are too many variables, both known and unknown, affecting construction contract changes to be able to predict those changes at the time of bid.

In a study by Rosemond (1984), a detailed analysis of 300 Navy construction contracts was performed. It was concluded that there was no direct relationship between any variable, or simple combination of variables, and the change order rate, which was defined as the percentage increase, or decrease, in contract price over the original award amount. There was no relationship found between change order rates and the number of bids, winning bid to mean bid ratio, type of facility, and unemployment levels at the time of contract. However, it was found that change order rates appeared to be higher when the low bid was at least 15% below the estimate, and that change order rates were significantly lower when the low bid was within 3% or more than 20% higher than the estimate. No significant difference in change order rates could be detected where the low bid was between 3 and 16% either higher or lower than the estimate.

Summary

Previous research efforts have provided a foundation for this research. Most of the previous research involved considerable efforts investigating changes in construction projects and their impact on the performance and other aspects of projects. Changes in

construction contracts not only lead to increased costs. Changes also lead to contract delays and affect all aspects of construction projects. Whether the amount of the changes can be predicted was a common question raised at the end of most of those studies.

Several research studies indicated that cost growth, overruns and underruns, in construction contracts include change orders. It was found that project change has a tremendous effect on the financial performance of construction projects. Factors that influence the construction change order rates causing cost overruns were identified. It was indicated that the estimating method and the accuracy of cost estimates could be major reasons for having cost changes. Size of project, difference between the low bid and the estimate, type of construction, level of competition, quality of contract documents, policies of the contractor, and others were factors that influence the construction change order rates. Several other factors and variables that could cause cost overrun were identified. Some of those factors were found to be known prior to the commencement of construction and could be used as early warning signs of project cost growth.

Several research studies were conducted in an attempt to predict the amount of construction cost increase. Factors that could be used in the prediction were determined and used. The results of the analysis of the relationship of change order rates to other variables thought to affect or to be useful in predicting change order rates were disappointing. Low correlation coefficients and inconsistent results were obtained during regression and other analyses. No direct relationships were found between any variable, or simple combination of variables, determined and used and the change order rate, which was defined as the change in contract cost over the original award amount.

CHAPTER III

DATA COLLECTION PROCEDURES

Introduction

This research was conducted in four phases. The first phase involved surveying ODOT engineers and contractors through two different questionnaires; the second phase involved the analysis of the responses to the questionnaires sent to the participants in the survey; the third phase involved the collection of project data about cost factors obtained from analyzing the responses to the survey, and the fourth phase involved the analysis of the data and the creation of the predicting model.

This chapter describes the first three phases of the research. Chapter IV discusses phase four related to data analysis.

Survey Questionnaires

Introduction

Cost change in the form of overrun or underrun in any construction project may occur due to several factors. These factors were called cost factors. Although previous studies established some of these factors, other factors were added in this research study

after several discussions with ODOT professionals and thesis committee members. The final list of factors consists of 33 cost factors.

Determining the existence, influence and effectiveness of each of the cost factors may lead to better control on construction cost and help to avoid expected cost overruns/underruns. To achieve this goal, there was a need for conducting a survey that included all parties involved in ODOT paving projects.

Objective

The main objective of the survey was to identify factors that are indicators of potential cost growth in ODOT paving projects. In addition, the purpose was to obtain the participants' responses about whether or not the 33 cost factors have an impact on the cost growth and the magnitude of the impact.

Target Population

Warde (1990) defined the target population as the population about or from which we would like to be able to draw inference. According to this definition, the target population in the research was considered to be ODOT engineers and construction contractors who deal with paving projects.

Survey Population

The survey population was defined by Warde as the population to or from which we can draw valid statistical inference. The survey population in this research was

considered to be ODOT engineers and contractors who could be reached to be questioned in the survey.

Frame

Lists for division engineers, construction engineers, resident engineers and prequalified contractors were provided by ODOT. They were used as the frame in the survey. Names, positions, telephone numbers, fax numbers and mailing addresses were given in each list.

Frame Problems

Three important points should be considered when using the previously mentioned lists as a frame in order to construct or use the frame correctly. The points are as follows:

1. The survey population, not the target population, should be used.
2. The frame must contain every element of the survey population.
3. The frame must contain each element once.

Since these points were slightly violated in one way or another, several problems were observed when trying to construct and use the frame. These problems were:

a. Missing Elements or Non-Coverage. This usually occurs when elements from the survey population do not appear in the frame. An example of this type of problem is resident engineers and contractors who previously worked with ODOT on projects included in the research, but their names and addresses were no longer included in the list provided by ODOT. To solve this problem, all resident engineers and contractors

whose names were mentioned in any of the projects included in the research were obtained from the old lists available at ODOT. Projects with names that could not be found on any list were excluded from the study.

b. Blanks or Foreign Elements. This problem usually occurs when some elements appear in the lists while they are not elements in the survey population. As an example, some contractors were included in the lists while they did no paving projects with ODOT. They were considered foreign elements since the study was restricted to paving projects actually completed. Questionnaires returned with any indication of this problem were excluded from the study.

c. Duplication. This type of problem usually occurs when elements of the survey population appear more than once in the lists used as a frame. ODOT usually updates its contractors' list by adding and deleting names. Some names were found to appear more than once on the list. This problem was solved by going through the names, considering the first entry to be the only valid occurance of that element.

Sampling Design

The basic sampling design considered in the survey was the census. All engineers and contractors appearing on the ODOT lists were included in the survey. All elements of the survey population were included in the survey in order to get representative answers for the questionnaires.

Data Collection Method

Four generally accepted methods were available for the collection of data in the survey. The methods were as follows:

1. Personal Interviews. This method involves collecting data by an interviewer directly from every element in the survey.
2. Telephone Interviews. This method involves contacting the respondents on the telephone, asking them questions and recording their answers.
3. Self-administered questionnaires. This method involves collecting the data from questionnaires that were completed by respondents.
4. Examination of available data. In this method, the data have already been collected and available to the researcher for further analysis.

Self-administered questionnaires were used as the method of data collection in the research. Considering this method, the data were collected through the respondents' completion of the questionnaire. The self-administered method was selected based on the following considerations:

- Time. Due to the fact that other steps in the research could not be started until the participants' responses to the survey were collected and analyzed, self-administered questionnaires were found to be the most suitable method.
- Expense. Self-administered was believed to be the most economical method of conducting a survey since the only costs were printing and postage for distribution of the questionnaires.
- Bias. This was an important reason for selecting the self-administered method. This method was believed to have the least bias compared to the others.

Questionnaire Design

As mentioned previously, the survey was considered as a self-adminstered questionnaire. Since two different populations were involved, ODOT engineers and contractors, two different questionnaires were designed. Cost factors were divided into three groups: factors related to ODOT engineers, contractors, and both groups. Each questionnaire contained cost factors related to the targeted group.

The engineers' questionnaire consisted of three pages. The first page was the cover letter. The objective of the project, confidentiality guarantee, deadline and brief instructions were included in this page, as shown in Appendix B. The latter two pages contained questions about 22 different cost factors and an extra field for added ones. The engineers' questionnaire is shown in Figure 2.

The contractors' questionnaire consisted also of three pages. The first page was the same cover letter. The latter two pages contained evaluation questions about 28 cost factors and an extra field for added ones. The contractors' questionnaire is shown in Figure 3.

Seventeen cost factors were common to both engineers' and contractors' questionnaires. Thus, there were 5 factors that were unique to engineers and 11 factors that were unique to contractors.

In both questionnaires, a subjective opinion was requested. Opinion questions were designed to determine how the respondents think about different cost factors.

Typal or Likert scale was the method used to obtain information from the participants. The scale used was asymetric allowing only four points or options. The labels were no impact, minor impact, moderate impact, and major impact. The

Predicting construction cost growth in ODOT's paving projects using information available at the bidding time

Please indicate whether or not the following factors have an impact or influence on the cost growth in ODOT's paving projects. Note that marking minor, moderate or major impact for any factor means that a relationship is assumed to exist between cost growth and that factor, and the factor can be used as an indicator for cost growth, whether it is an overrun or underrun.

	No Impact	Minor Impact	Moderate Impact	Major Impact
1. Project type (Surfacing, Resurfacing or Overlay)	O	O	O	O
2. Project size (volume of work involved in a project)	O	O	O	O
3. Project location (County in which the project took place)	O	O	O	O
4. Project duration	O	O	O	O
5. Weather	O	O	O	O
6. Method of estimating	O	O	O	O
7. Availability of construction-cost data	O	O	O	O
8. Bidding environment	O	O	O	O
9. Period between design and time of bidding	O	O	O	O
10. Time allowed to review plans for bidding	O	O	O	O
11. Number of bids	O	O	O	O
12. Bid range (the difference between the highest and the lowest bids, low-to-high bid range)	O	O	O	O
13. Money left on table (the difference between the lowest and the second lowest bids)	O	O	O	O
14. Difference between the engineer's estimate and the contract amount	O	O	O	O
15. Timing of work order	O	O	O	O
16. Contractor performing the work	O	O	O	O
17. Contractor's history of cost overrun	O	O	O	O
18. Contractor's participation in several projects at the same time	O	O	O	O
19. Fraudulent practices by Contractors	O	O	O	O
20. Resident Engineer	O	O	O	O
21. Mode of payment for completed work	O	O	O	O
22. Contract administration	O	O	O	O
23. Other factors				
a)	O	O	O	O
b)	O	O	O	O
c)	O	O	O	O

Figure 2 – The Engineers' Questionnaire

Predicting construction cost growth in ODOT's paving projects using information available at the bidding time

Please indicate whether or not the following factors have an impact or influence on the cost growth in ODOT's paving projects. Note that marking minor, moderate or major impact for any factor means that a relationship is assumed to exist between cost growth and that factor, and the factor can be used as an indicator for cost growth, whether it is an overrun or underrun.

	No Impact	Minor Impact	Moderate Impact	Major Impact
1. Project type (Surfacing, Resurfacing or Overlay)	O	O	O	O
2. Project size (volume of work involved in a project)	O	O	O	O
3. Project location (County in which the project took place)	O	O	O	O
4. Project duration	O	O	O	O
5. Weather	O	O	O	O
6. Bureaucracy of bidding method	O	O	O	O
7. Bidding environment	O	O	O	O
8. Period between design and time of bidding	O	O	O	O
9. Time allowed to review plans for bidding	O	O	O	O
10. Metric/English units confusion (in plans and specifications)	O	O	O	O
11. Government policies, restrictions, and regulations	O	O	O	O
12. Out-of-state construction firms	O	O	O	O
13. Mode of payment for completed work	O	O	O	O
14. Method of estimating	O	O	O	O
15. Availability of construction-cost data	O	O	O	O
16. Contractor's participation in several projects at the same time	O	O	O	O
17. Number of bids	O	O	O	O
18. Money left on table (the difference between the lowest and the second lowest bids)	O	O	O	O
19. Timing of work order	O	O	O	O
20. Resident Engineer	O	O	O	O
21. Availability of labor	O	O	O	O
22. Fluctuation in prices of materials	O	O	O	O
23. Availability of equipment	O	O	O	O
24. Contract administration	O	O	O	O
25. Interim financing	O	O	O	O
26. Control of internal cost	O	O	O	O
27. Interest rates on operating funds	O	O	O	O
28. Waste on the job site	O	O	O	O
29. Other factors				
a)	O	O	O	O
b)	O	O	O	O
c)	O	O	O	O

Figure 3 – The Contractors' Questionnaire

respondent was asked to indicate whether or not each of the given cost factors have an impact on the cost growth, and to assess the magnitude of the impact by marking one of the labels in front of that particular factor.

Pretest and Validation

Before distributing the questionnaires, members of the graduate committee and selected ODOT engineers reviewed and critiqued the questionnaires to ensure that participants could respond to them with no difficulties. Additional modifications to the questionnaires were made to improve them based on suggestions of the committee and ODOT personnel. Validity of the questionnaires was determined by considering the following:

1. Are factors that are relevant to respondents included?
2. Are factors presented in a clear and unambiguous way?
3. Are respondents willing to give the information requested in the questionnaire?

Analysis of Responses

While conducting the survey, several items were taken into consideration to achieve the maximum possible response rate. Some of these items were as follows:

- Appearance of the questionnaire. The length and appearance of the questionnaire were believed to have a major effect on the response rate; long and poor looking questionnaires result in greater non-response. Since it was recognized that ODOT

engineers and contractors had limited time to spend in answering questions, the questionnaires were short, clear and easy to answer.

- Cover letter. A cover letter was prepared on official, formal paper and attached to each questionnaire. It contained a brief description about the research and simple instructions on how to complete and return the questionnaire. Several statements were also added to assure the participants maximum confidentiality and to indicate how important and beneficial their participation would be in order to achieve the research objectives.
- Type of mailing. Prepaid self-addressed return envelopes were attached to the questionnaires for use by respondents. This was believed to create an obligation on the part of respondents who were inclined to throw the questionnaires away. The researcher believed that self-addressed return envelopes contributed to a higher response rate.
- Confidentiality of responses. The promise to keep the respondents' answers confidential provided a sense of security. In the cover letter attached to each questionnaire, participants were assured strict confidentiality and that at no time would they be identified in the research results.
- Use of deadline. Because the researcher believed that a pre-set deadline for responses could improve the response rate, it was used and mentioned in the cover letter. Care was taken to choose a deadline to allow sufficient time for preparing, sending, receiving and responding to the questionnaires.

Of the 203 questionnaires sent by mail to participants, 159 were distributed to contractors and 44 to ODOT engineers. Table 1 is a summary of the responses.

Table 1 – A Summary of the Responses to the Questionnaires

Participant	Sent	Received			Response Rate
		Mail	Fax	Total	
Engineers	44	26	1	27	61.36%
Contractors	159	48	2	50	31.45%

Determination and Ranking of Factors

After the participants' responses were received, a simple analysis was performed to determine the impact and extent that each factor has on the cost growth. The analysis provided a ranking for each factor with respect to other factors included in the questionnaires. This analysis provided the relative importance of the factors from the perspective of the participants.

A summary of the participants' responses to different factors included in the owners' and contractors' questionnaires is shown in Tables 2 and 3 respectively.

In the engineers' questionnaire, all 22 factors except bid range were found to have impact on cost growth. Since it was believed that there should be some sort of relationship between bid range and cost growth, it was decided to involve all 22 factors in the analysis process.

In the contractors' questionnaire, all 28 factors except contract administration were found to have impact on cost growth. Because no data were found about contract administration for paving projects in ODOT files, this factor was ignored and not included in the analysis.

Table 2 – Participants' Responses to Factors included in the Engineers' Questionnaires

Factor	No Impact	Minor Impact	Moderate Impact	Major Impact
1. Project type (Surfacing, Resurfacing or Overlay)	3	11	8	5
2. Project size (volume of work involved in a project)	2	7	9	9
3. Project location (County in which the project took place)	5	7	9	6
4. Project duration	4	11	11	1
5. Weather	7	14	5	1
6. Method of estimating	8	9	6	3
7. Availability of construction-cost data	10	11	2	2
8. Bidding environment	3	4	11	7
9. Period between design and time of bidding	2	9	13	3
10. Time allowed to review plans for bidding	5	6	13	1
11. Number of bids	3	9	8	5
12. Bid range (the difference between the highest and the lowest bids, low-to-high bid range)	9	8	7	1
13. Money left on table (the difference between the lowest and the second lowest bids)	7	9	7	2
14. Difference between the engineer's estimate and the contract amount	10	11	3	2
15. Timing of work order	2	10	12	3
16. Contractor performing the work	5	4	10	8
17. Contractor's history of cost overrun	6	7	8	5
18. Contractor's participation in several projects at the same time	3	4	12	7
19. Fraudulent practices by Contractors	8	11	3	3
20. Resident Engineer	5	10	9	3
21. Mode of payment for completed work	8	13	3	2
22. Contract administration	4	12	9	1

Table 3 – Participants' Responses to Factors included in the Contractors' Questionnaires

Factor	No Impact	Minor Impact	Moderate Impact	Major Impact
1. Project type (Surfacing, Resurfacing or Overlay)	12	14	12	8
2. Project size (volume of work involved in a project)	3	6	17	20
3. Project location (County in which the project took place)	3	16	13	14
4. Project duration	1	15	21	10
5. Weather	0	12	15	19
6. Bureaucracy of bidding method	7	18	10	12
7. Bidding environment	9	16	14	7
8. Period between design and time of bidding	13	24	6	4
9. Time allowed to review plans for bidding	2	17	24	4
10. Metric/English units confusion (in plans and specifications)	7	14	11	15
11. Government policies, restrictions, and regulations	0	8	19	20
12. Out-of-state construction firms	14	13	16	4
13. Mode of payment for completed work	9	12	17	9
14. Method of estimating	12	26	8	0
15. Availability of construction-cost data	16	19	10	1
16. Contractor's participation in several projects at the same time	4	14	17	12
17. Number of bids	8	17	15	7
18. Money left on table (the difference between the lowest and the second lowest bids)	12	20	9	5
19. Timing of work order	5	11	21	10
20. Resident Engineer	3	13	18	13
21. Availability of labor	0	6	18	23
22. Fluctuation in prices of materials	2	12	20	13
23. Availability of equipment	8	19	16	4
24. Contract administration	16	15	13	3
25. Interim financing	16	22	6	2
26. Control of internal cost	10	22	11	3
27. Interest rates on operating funds	11	20	13	2
28. Waste on the job site	5	25	9	7

All factors that had impact on cost growth as obtained from participants' responses to both questionnaires were considered in the analysis process. Each factor was considered as a variable.

ODOT files were then examined to ensure information was available on each project involved in the study. Information related to 19 of the factors was found. Information on the remaining 14 factors was found to be unavailable. Table 4 shows the unavailable factors and the reasons behind the unavailability of information in the files.

Collection of Project Information

Introduction

In the previous section, factors that had impact on cost growth were identified and considered as variables in projects. For each project included in the analysis, there was input for each one of the variables. If data for the variables were not available directly from ODOT files, it was obtained either by performing simple calculations on the available information or by other ways as explained in the following section.

Selection Criteria

Data about ODOT projects were key to the research. Prior to searching ODOT files and databases, selection criteria were established to meet the scope of the research. This research applies only to paving projects that were awarded and completed between January 1995 and December 1998 with contract amounts less than or equal to 5

Table 4 - The Unavailable Factors and the Reasons behind their Unavailability

Factor	Related to			Impact		Reason for Unavailability
	Contractors	Owners	Both	Contractors	Owners	
1. Method of estimating			x	Minor	Minor	Not available in ODOT's files of projects.
2. Availability of construction-cost data			x	Minor	Minor	Not available in ODOT's files of projects.
3. Bureaucracy of bidding method	x			Minor	N/A	General, no unique input for each project.
4. Government policies, restrictions, and regulations	x			Major	N/A	General, no unique input for each project.
5. Contractor's participation in several projects at the same time			x	Moderate	Moderate	Not available in ODOT's files of projects.
6. Fraudulent practices by Contractors		x		N/A	Minor	Not available at bidding time.
7. Fluctuation in prices of materials	x			Moderate	N/A	Not available at bidding time.
8. Availability of equipment	x			Minor	N/A	Not available at bidding time.
9. Mode of payment for completed work			x	Moderate	Minor	General, no unique input for each project.
10. Contract administration			x	No	Minor	Not available in ODOT's files of projects.
11. Interim financing	x			Minor	N/A	Not available in ODOT's files of projects.
12. Control of internal cost	x			Minor	N/A	Not available in ODOT's files of projects.
13. Interest rates on operating funds	x			Minor	N/A	Not available in ODOT's files of projects.
14. Waste on the job site	x			Minor	N/A	Not available in ODOT's files of projects.

million dollars. Only projects meeting those criteria were included in the research.

Search Process

After the search criteria were established, ODOT files and databases were searched. Most of the needed information related to completed paving projects was available in the files and databases of the Construction Division and Office Engineer offices at ODOT.

The search process began at the offices of the Construction Division. "Record of Payments on Contracts" files were searched. Project descriptions, surfacing, resurfacing and overlaying, award date, completion date, and contract amount were identified and recorded.

At the Office Engineer offices, "Bid Opening Reports" were searched. These reports, sometimes called Bid Tabs, were collected for the period between January 1995 and December 1998. The "Letting Date" and "Project Number" in the "Bid Tabs" files were matched with those that appeared on the "Record of Payments". By combining the information retrieved from both sources, a complete set of information was gathered for projects that met the selection criteria.

Project Data

For each project included in the study, the following information was retrieved and gathered directly from the files:

- Project number.
- Project location.

- Project type.
- Letting date.
- Number of bids.
- Lowest bid.
- Second lowest bid.
- Highest bid.
- Engineers' estimate.
- Contract amount.
- Actual cost.
- Duration.
- Contractor.
- Existence of out-of-state contractor in the bidding process.
- Work order date.
- Number of bad weather days.
- Resident engineer.

Figures representing the following information were calculated and obtained from the previously collected data:

- Money left on table.
- Bid range.
- Contract difference.
- Cost growth.
- Bad weather days ratio.
- Bidding environment.

- Timing of work orders.
- Number of paving projects awarded to contractor.
- Number of projects in which an overrun existed.
- Ratio of that number to total number of projects.
- Average overrun for contractor.
- Average cost growth for contractor.

Information about English and metric unit systems used in preparing plans and specifications of different projects was obtained directly from ODOT engineers. The Oklahoma Department of Labor was contacted and monthly unemplyment rate figures for the specified period were provided.

Data Entry, Storage, and Processing

Prior to data collection, it was recognized that there was a need to establish a database to make entering, storing, and processing the data easier and more flexible. Therefore, Microsoft Access was used to design and create a database containing project data.

Several tables were first created to contain project data gathered directly from ODOT files. Queries were then designed and created to perform simple calculations on the data to calculate values for each of the projects.

Because forms were believed to be the most suitable part of a database that can be used as an input screen, two forms were created. The first form, Data Entry Form, was used as an input screen. All data and information related to a project and collected from ODOT files appear on a single sheet. After each entry is made in the form about data for

a particular project, a new sheet appears automaticaly to allow for another project's data input. A data entry form for a selected project is shown in Figure 4.

The second form, Data Analysis Form, contained all information on the first form plus fields for calculating values from the existing data. All project data and information that were used in the analysis processes are shown on the Data Analysis Form. A data analysis form for a selected project is shown in Figure 5.

Data Preparation for Analysis

All project information from both forms was stored directly in a table in the database. The table was designed and created using Access. It arranged the projects data in a row and column format; each row represented a project and the columns represented data and information collected, obtained, and calculated specifically for that particular project. The table was compatible with Excel and SAS. This made the information accessible and useable during the analysis phase without any further transformations.

The entire set of 266 paving projects collected and prepared for analysis and their data are shown in Appendix C.

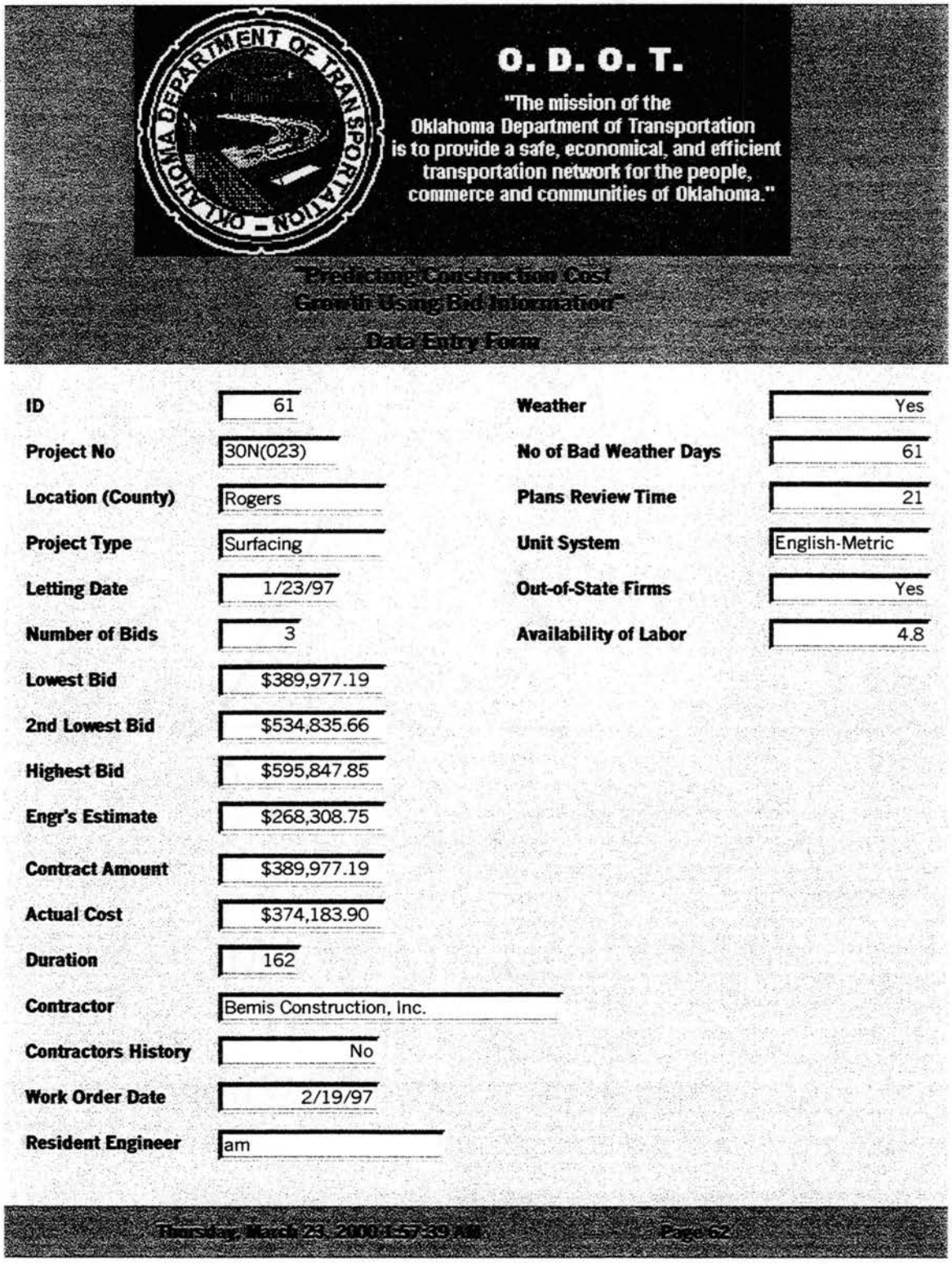


Figure 4 – A Data Entry Form for a Selected Project

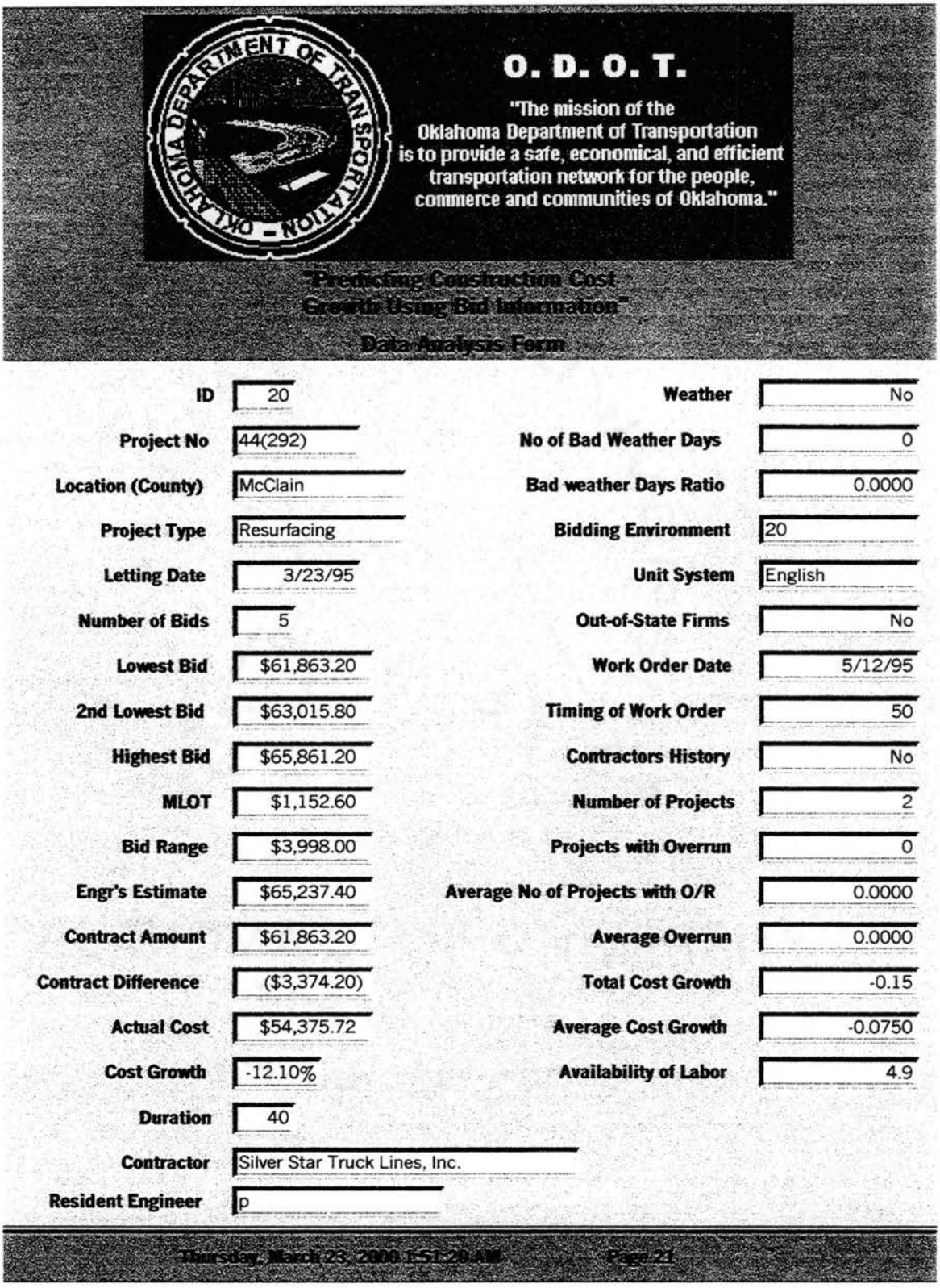


Figure 5 - A Data Analysis Form for a Selected Project

Demographics of the Projects

Data from 266 paving projects were collected from ODOT files. Figure 6 provides a breakdown of the projects by project type. The vast majority of the projects, 210, were resurfacing projects. The number of surfacing and overlay projects was low.

Figure 7 shows the distribution of the projects by letting date. On the horizontal axis of the chart, the numbers 1, 2, 3, and 4 represent the years 1995, 1996, 1997, and 1998 respectively. Among the 266 projects included in the analysis, more projects were let in 1995 than any other year.

Figure 8 represents the breakdown of the projects by contract amount. The contract amount was divided into 7 categories. The largest number of projects was in the $500,001-$1,000,000 category. The smallest number of projects was in the >$1,000,000 category.

Figure 9 shows the breakdown of the projects by the English or metric unit system used by ODOT in preparing plans and specifications for the projects included in the research. Projects in which both English and metric unit systems were considered were more than those in which only the English system was considered.

Figure 10 represents the distribution of the collected projects by duration. The duration was divided into 7 categories. The largest number of projects was in the 60-120 day category.

Figure 11 provides a breakdown of the projects by type of cost change. The vast majority of the projects, 202, included in the research had underrun. Fifty-nine projects had a cost overrun. Only five projects were completed on budget.

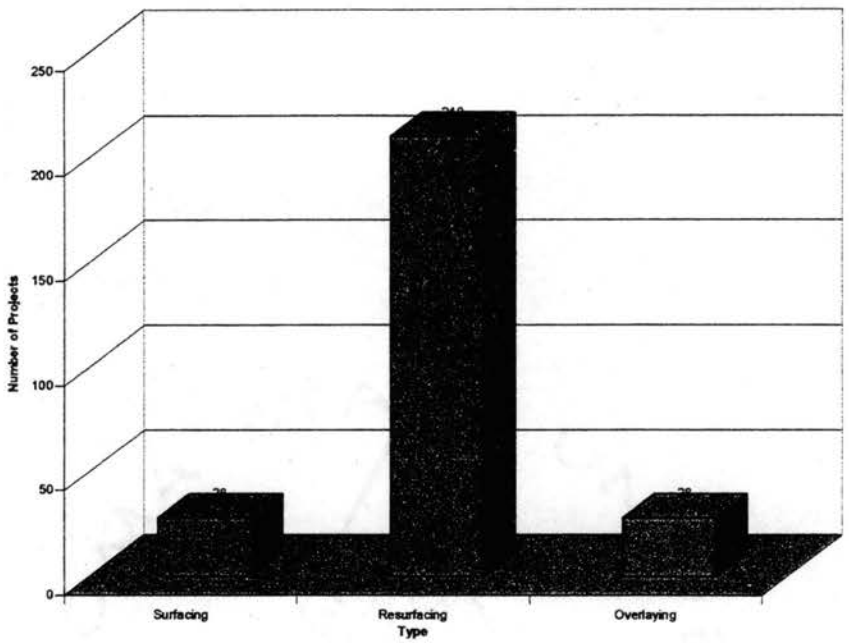


Figure 6 – Distribution of Projects by Type

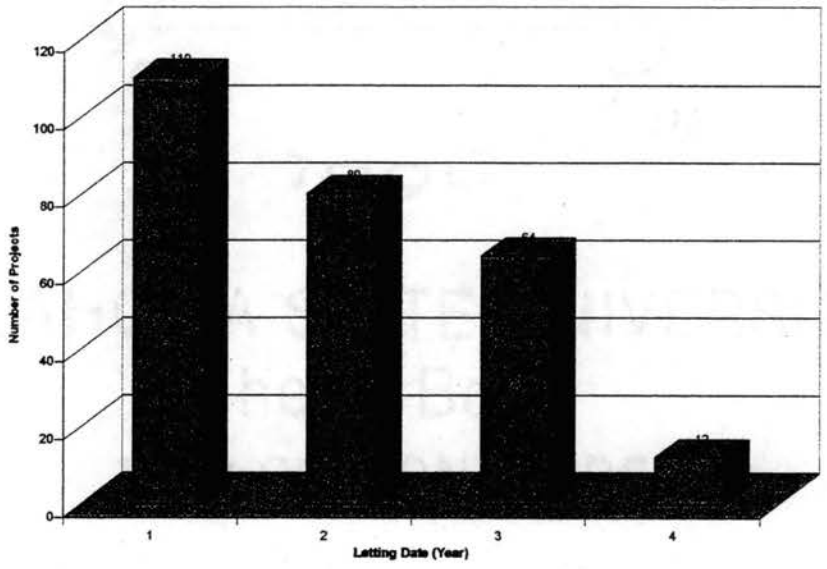


Figure 7 – Distribution of Projects by Letting Date
(Legend: 1-1995, 2-1996, 3-1997, 4-1998)

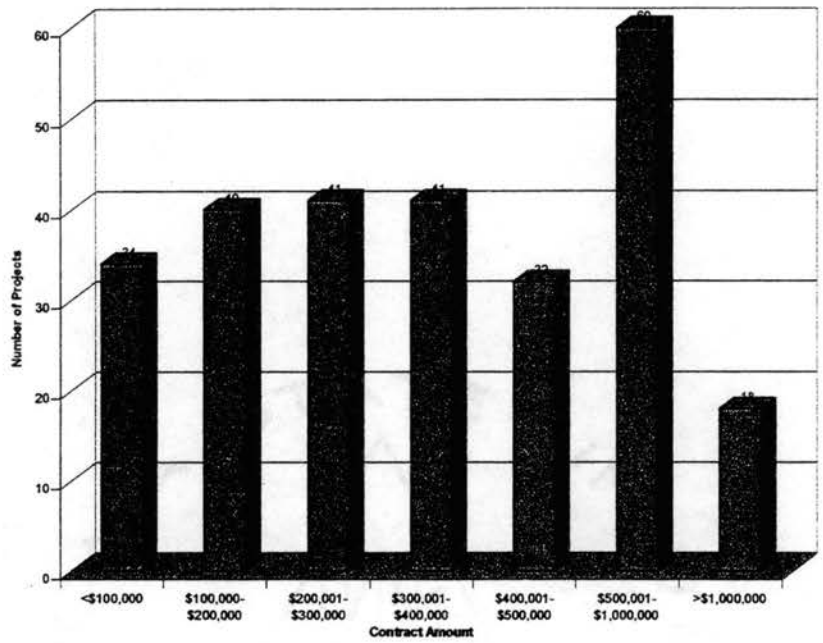


Figure 8 – Distribution of Projects by Contract Amount

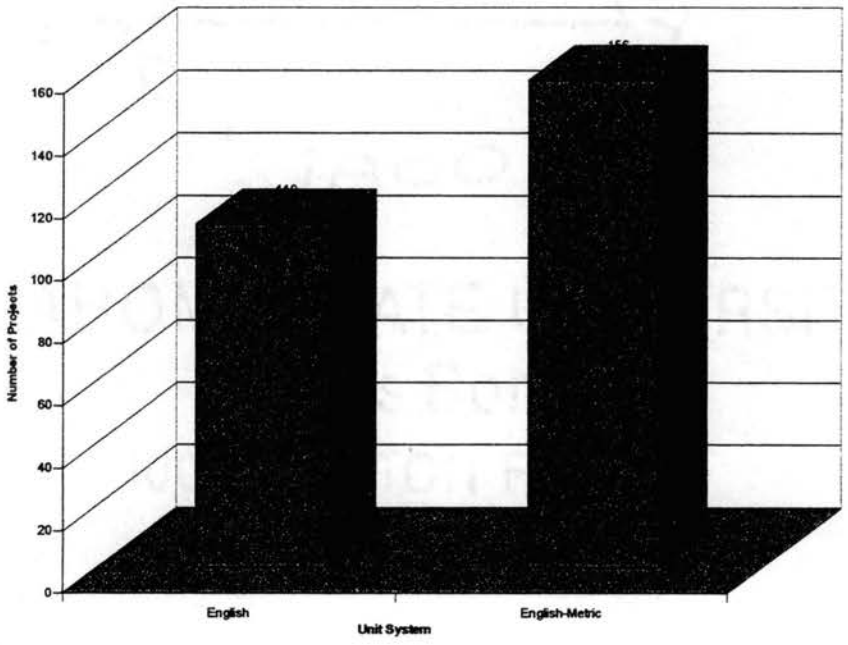


Figure 9 – Distribution of Projects by Unit System

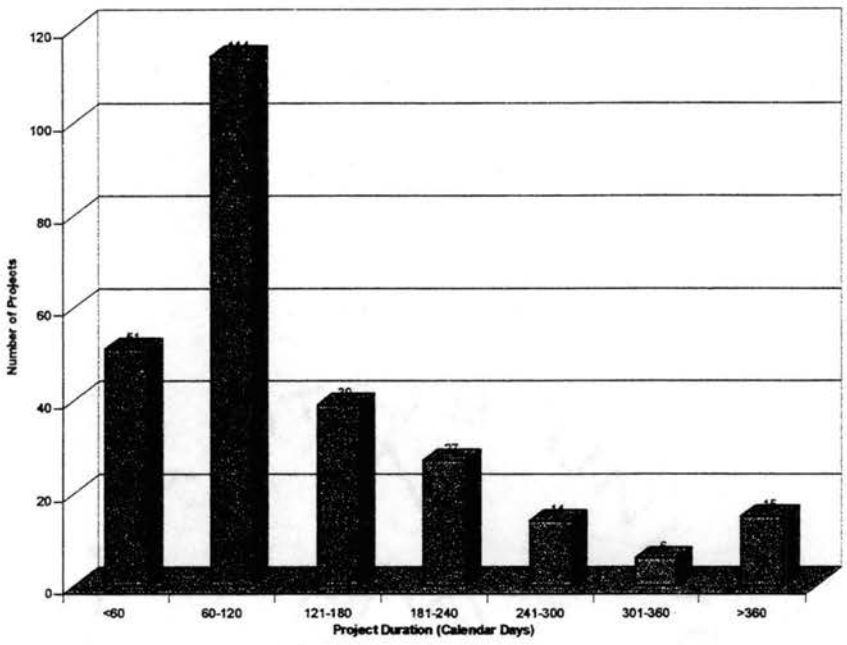


Figure 10 – Distribution of Projects by Duration

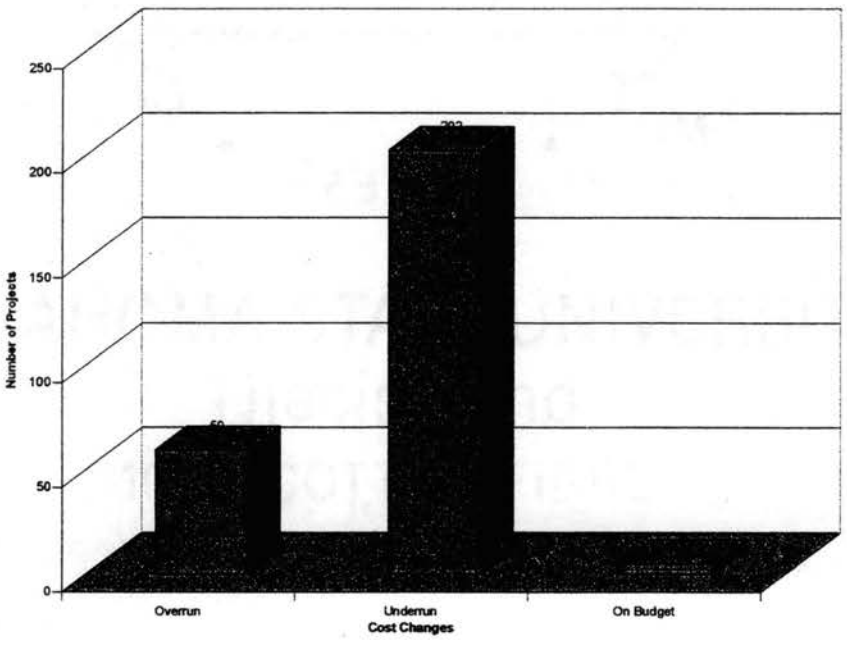


Figure 11 – Distribution of Projects by Cost Changes

CHAPTER IV

DATA ANALYSIS TECHNIQUES AND STATISTICS

Introduction

The analysis phase of the research started after participants' responses were received and project data were collected. Responses of both questionnaires were analyzed to determine the severity index of each included factor and that index was used in the ranking process. Also, the analysis of the responses was important in determining factors to be used as variables while collecting project information.

After project data related to the specified factors were collected from ODOT files, principal components analysis was performed for two main reasons: to check whether there were outliers in the data and to get a correlation matrix that gives an indication of the relationship among the included factors, or variables.

Factor analysis was then performed on the numeric portion of the data to overcome the multicollinearity problem. Factors, or project variables, were grouped into meaningful subdivisions, or principal factors. No relationship was supposed to exist among them. Principal factors to be included in the development of the prediction model were then determined.

The principal factors and the non-numeric variables were then combined and multiple regression analysis was then performed on them based on the 266 observations. The final prediction model was then created based on the results of this analysis.

The Survey

Questionnaires were distributed and collected as described in Chapter III. Responses to each factor included in the questionnaires were recorded. The total number of responses to a particular factor was recorded on the same line under the selected degree of impact. For example, if 11 participants marked the factor "Project Type" to have minor impact on cost growth, 11 would be written in the field in front of project type and under minor impact.

Severity index was then calculated for every factor included in the questionnaires. The formula used for calculating the severity index was as follows:

$$\text{Severity Index} = (1 * \text{No Impact}) + (2 * \text{Minor Impact}) + (3 * \text{Moderate Impact}) + (4 * \text{Major Impact}) \quad \text{Equation 4.1}$$

where:

No Impact = number of times the factor was marked to have no impact

Minor Impact = number of times the factor was marked to have minor impact

Moderate Impact = number of times the factor was marked to have moderate impact

Major Impact = number of times the factor was marked to have major impact.

Tables 5 and 6 represent responses of engineers' and contractors' questionnaires respectively. Severity index of every factor, calculated as mentioned above, is shown in the last column of the tables.

Table 5 – Responses of Engineers' Questionnaires including Severity Indices

Factor	No Impact	Minor Impact	Moderate Impact	Major Impact	No Answer	Severity Index
1. Project type	3	11	8	5	0	69
2. Project size	2	7	9	9	0	79
3. Project location	5	7	9	6	0	70
4. Project duration	4	11	11	1	0	63
5. Weather	7	14	5	1	0	54
6. Method of estimating	8	9	6	3	1	56
7. Availability of construction-cost data	10	11	2	2	2	46
8. Bidding environment	3	4	11	7	2	72
9. Period between design and time of bidding	2	9	13	3	0	71
10. Time allowed to review plans for Bidding	5	6	13	1	2	60
11. Number of bids	3	9	8	5	2	65
12. Bid range	9	8	7	1	2	50
13. Money left on table	7	9	7	2	2	54
14. Difference between the Engineer's estimate and the contract amount	10	11	3	2	1	49
15. Timing of work order	2	10	12	3	0	70
16. Contractor performing the work	5	4	10	8	0	75
17. Contractor's history of cost overrun	6	7	8	5	1	64
18. Contractor's participation in several projects at the same time	3	4	12	7	1	75
19. Fraudulent practices by Contractors	8	11	3	3	2	51
20. Resident Engineer	5	10	9	3	0	64
21. Mode of payment for completed work	8	13	3	2	1	51
22. Contract administration	4	12	9	1	1	59

Table 6 – Responses of Contractors' Questionnaires including Severity Indices

Factor	No Impact	Minor Impact	Moderate Impact	Major Impact	No Answer	Severity Index
1. Project type	12	14	12	8	4	108
2. Project size	3	6	17	20	4	146
3. Project location	3	16	13	14	4	130
4. Project duration	1	15	21	10	3	134
5. Weather	0	12	15	19	4	145
6. Bureaucracy of bidding method	7	18	10	12	3	121
7. Bidding environment	9	16	14	7	4	111
8. Period between design and time of Bidding	13	24	6	4	3	95
9. Time allowed to review plans for Bidding	2	17	24	4	3	124
10. Metric/English units confusion	7	14	11	15	3	128
11. Government policies, restrictions, and regulations	0	8	19	20	3	153
12. Out-of-state construction firms	14	13	16	4	3	104
13. Mode of payment for completed work	9	12	17	9	3	120
14. Method of estimating	12	26	8	0	4	88
15. Availability of construction-cost data	16	19	10	1	4	88
16. Contractor's participation in several projects at the same time	4	14	17	12	3	131
17. Number of bids	8	17	15	7	3	115
18. Money left on table	12	20	9	5	4	99
19. Timing of work order	5	11	21	10	3	130
20. Resident Engineer	3	13	18	13	3	135
21. Availability of labor	0	6	18	23	3	158
22. Fluctuation in prices of materials	2	12	20	13	3	138
23. Availability of equipment	8	19	16	4	3	110
24. Contract administration	16	15	13	3	3	97
25. Interim financing	16	22	6	2	4	86
26. Control of internal cost	10	22	11	3	4	99
27. Interest rates on operating funds	11	20	13	2	4	98
28. Waste on the job site	5	25	9	7	4	110

After severity indices were calculated, the ranking process involved arranging the factors according to their severity indices, starting with the factor that had the largest severity index. Because some factors had the same severity index, the previously described ranking process alone did not assign every factor a unique rank. The severity index was considered a primary ranking. A secondary and final ranking process was performed in order to assign an advanced order in rank to the factor that had larger number of "Major Impact" marks.

The overall degree of impact of the factors was then determined. Each factor was assigned the degree of impact that received the maximum number of marks according to the questionnaires. In the engineers' questionnaire, all 22 factors, except bid range, were found to have impact on cost growth. Since it was believed that there was some sort of relationship between bid range and cost growth, the researcher decided to include all 22 factors in the analysis process.

In the contractors' questionnaire, all 28 factors, except contract administration, were found to have impact on cost growth. Because no data were found about contract administration for paving projects in ODOT files, it was decided to exclude that factor from the analysis.

All factors that had impact on cost growth, as obtained from participants' responses to both questionnaires, were included in the analysis process. Each factor was to be considered as a variable. Table 7 shows the factors included in both engineers' and contractors' questionnaires, their overall impact, and their ranking.

Table 7 – Factors included in the Questionnaires, their Impact, and Ranking

Factor	Impact		Rank	
	Contractors	Engineers	Contractors (1-28)	Engineers (1-22)
1. Project type	Minor	Minor	19	8
2. Project size	Major	Major	3	1
3. Project location	Minor	Moderate	9	6
4. Project duration	Moderate	Moderate	7	12
5. Weather	Major	Minor	4	17
6. Method of estimating	Minor	Minor	27	15
7. Availability of construction-cost data	Minor	Minor	26	22
8. Bureaucracy of bidding method	Minor	N/A	13	N/A
9. Bidding environment	Minor	Moderate	16	4
10. Period between design and time of bidding	Minor	Moderate	25	5
11. Time allowed to review plans for bidding	Moderate	Moderate	12	13
12. Metric/English units confusion	Major	N/A	11	N/A
13. Government policies, restrictions, and Regulations	Major	N/A	2	N/A
14. Out-of-state construction firms	Moderate	N/A	20	N/A
15. Number of bids	Minor	Minor	15	9
16. Bid range	N/A	No	N/A	20
17. Money left on table	Minor	Minor	21	16
18. Difference between the Engineer's estimate and the contract amount	N/A	Minor	N/A	21
19. Timing of work order	Moderate	Moderate	10	7
20. Contractor performing the work	N/A	Moderate	N/A	2
21. Contractor's history of cost overrun	N/A	Moderate	N/A	10
22. Contractor's participation in several projects at the same time	Moderate	Moderate	8	3
23. Fraudulent practices by Contractors	N/A	Minor	N/A	18
24. Resident Engineer	Moderate	Minor	6	11
25. Availability of labor	Major	N/A	1	N/A
26. Fluctuation in prices of materials	Moderate	N/A	5	N/A
27. Availability of equipment	Minor	N/A	18	N/A
28. Mode of payment for completed work	Moderate	Minor	14	19
29. Contract administration	No	Minor	24	14
30. Interim financing	Minor	N/A	28	N/A
31. Control of internal cost	Minor	N/A	22	N/A
32. Interest rates on operating funds	Minor	N/A	23	N/A
33. Waste on the job site	Minor	N/A	17	N/A

ODOT files were then examined to ensure availability of information on each project involved in the study. Information related to 19 of the factors was found. No information was found for the remaining 14 factors. Both groups of variables are shown in Table 8. Table 4 in Chapter III represents the unavailable factors and the reasons behind the unavailability of information in the files.

Table 8 – Availability of the Factors included in the Questionnaires

Available Factors	Unavailable Factors
1.Project type	1.Method of estimating
2.Project size	2.Availability of construction-cost data
3.Project location	3.Bureacracy of bidding method
4.Project duration	4.Govmnt. policies, restrictions, and regulations
5.Weather	5.Contractors' participation in several projects at the same time
6.Bidding environment	6.Fraudulent practices by contractors
7.Period between design and time of bidding	7.Fluctuation in prices of materials
8.Time allowed to review plans for bidding	8.Availability of equipment
9.Metric/English unit confusion	9.Mode of payment for completed work
10.Out-of-state construction firms	10.Contract administration
11.Number of bids	11.Interim financing
12.Bid range	12.Control of internal cost
13.Money left on table	13.Interest rates on operating funds
14.Difference between the engineers' estimate and the contract amount	14.Waste on the job site
15.Timing of work order	
16.Contractor performing the work	
17.Contractors' history of cost overrun	
18.Resident Engineer	
19.Availability of labor	

Factors Included in the Analysis

As described previously, thirty-three factors were included in the questionnaires; twenty-two factors were related to engineers and twenty-eight to contractors. Also, it was described previously and shown in Table 8 that 19 factors were identified as available factors. Information related to those factors, or variables, on each project involved in the study was found and the factors were included in the analysis as variables. Table 9 represents the primary list of factors included in the analysis. Only available factors were considered in further analysis procedures.

Since the research was restricted to paving projects, "Project type" was found to be one of the three types: surfacing, resurfacing, or overlay.

"Project size" was reprsented by the contract amount in dollars.

The data used in the research were obtained from ODOT files for paving projects throughout the state. Therefore, any of the 77 counties in the State of Oklahoma was a possible input for "Project location".

"Project duration" was represented in the analysis by the number of calendar days awarded for each project.

The number of bad weather days for a project during construction was defined as "Bad weather days". Since it was obvious that big projects with long durations would have larger numbers to represent this variable than short-duration projects, it was necessary to include "Ratio of bad weather days" calculated as "Bad weather days" divided by "Duration".

Table 9 – Primary List of Factors included in the Analysis

No.	Factor	Related to		
		Engineers	Contractors	Availability
1	Project type	X	X	X
2	Project size	X	X	X
3	Project location	X	X	X
4	Project duration	X	X	X
5	Weather	X	X	X
6	Method of estimating	X	X	
7	Availability of construction-cost data	X	X	
8	Bureaucracy of bidding method		X	
9	Bidding environment	X	X	X
10	Period between design and time of bidding	X	X	X
11	Time allowed to review plans for bidding	X	X	X
12	Metric/English units confusion		X	X
13	Government policies, restrictions, and regulations		X	
14	Out-of-state construction firms		X	X
15	Number of bids	X	X	X
16	Bid range	X		X
17	Money left on table	X	X	X
18	Difference between the Engineer's estimate and the contract amount	X		X
19	Timing of Notice to Proceed	X	X	X
20	Contractor performing the work	X		X
21	Contractor's history of cost overrun	X		X
22	Contractor's participation in several projects at the same time	X	X	
23	Fraudulent practices by Contractors	X		
24	Resident Engineer	X	X	X
25	Availability of labor		X	X
26	Fluctuation in prices of materials		X	
27	Availability of equipment		X	
28	Mode of payment for completed work	X	X	
29	Contract administration	X	X	
30	Interim financing		X	
31	Control of internal cost		X	
32	Interest rates on operating funds		X	
33	Waste on the job site		X	
Total	**33**	**22**	**28**	**19**

"Bidding environment" was identified as a numeral value by the number of projects let by ODOT at the same month a project was awarded.

Except for very large and unique projects, designs of most of the paving projects were prepared by the same manner by ODOT designers and engineers. No large variation was found in the information related to "period between design and time of bidding". Therefore, this factor was excluded from the analysis.

A fixed number of days was given to contractors to review plans for bidding. Since the number was the same in all the projects, there was no variation in the data related to "Time allowed to review plans for bidding". Therefore it was excluded from the analysis.

Traditionally, the plans and specifications for ODOT Projects were prepared using the English unit system. In recent years, both English and metric systems were used. This led to the fact that "Metric/English unit confusion" was represented in the analysis by either English or English/metric.

"Out-of-State construction firms" denotes the existence of out-of-state construction firms in a project either as bidders or contractors. This factor, or variable, was represented in the analysis by either "yes" or "no".

"Number of bids" was represented by a simple number that indicates the number of bids submitted for a project.

"Bid range" was calculated as the difference between high and low bids. To avoid bias towards large projects, it was replaced with "Bid range ratio" caclulated as the bid range divided by the contract amount.

"Money left on table" was calculated as the difference between the low and the second low bids. Because it was believed that money left on table is directly related to size of the project, it was replaced with "Money left on table ratio" calculated as money left on table divided by contract amount.

"Difference between the engineers' estimate and the contract amount" was named "Contract difference". It was found to be greatly related to project size. Therefore, "Contract difference" was replaced with "Contract difference ratio" which was calculated as the difference between the engineers' estimate and the contract amount, divided by contract amount.

Since information about "Notice To Proceed" was available for the projects included in the study, "Timing of work order" was replaced with "Timing of Notice To Proceed", calculated as the period between contract award and notice to proceed, in calendar days.

"Contractor performing the work" and "Resident engineer" were simply named "Contractor" and "Resident engineer" respectively.

"Contractors' history of cost overrun" was represented by the number of projects the contractor had with ODOT, the number of projects in which the contractor had an overrun, the ratio of the number of projects with overrun to total number of projects, average amount of overrun in all projects that had overrun, and average cost growth the contractor experienced in all projects. They were named "Number of projects", "Number of projects with overrun", "Ratio of projects with overrun", "Average overrun", and "Average cost growth" respectively.

"Availability of labor" was represented by unemployment rate figures for the State at the time of bid opening. These were simply named "Unemployment rate".

For the reasons mentioned above, factor 7 "Period between design and time of bidding" and factor 8 "Time allowed to review plans for bidding" of available factors shown in Table 8 were excluded from the analysis. Also, Factor 5 "Weather" and factor 17 "Contractors' history of cost overrun" were replaced with 2 and 5 new factors respectively. Therefore, a final list of 22 factors was included in the analysis. As mentioned previously, these factors were considered variables in the analysis phase. Of these 22 variables, 16 were numeric and 6 were nonnumeric, or categoric.

In addition to the 22 variables, "Project identification number" was added as an identifier. "Cost growth" was considered as the dependent variable in the analysis. Thus, the total list contained 24 variables.

Each variable included in the analysis was assigned a symbol rather than the variable name. The project identification number was given the symbol "id", the 22 independent variables were given symbols from x1 to x22, and the dependent variable was assigned the symbol "Y". Table 10 shows the final list of 24 variables , their symbols, types , and units.

Principal Components Analysis

From the total list of 24 variables shown in Table 10, a principal components analysis was performed on the 16 numeric variables based on the 266 observations (projects). Principal components analysis is a variable-directed multivariate method

concerned with relationships that might exist among variables being measured. It was performed to screen the data for possible outliers. Outliers are defined as sample data points that appear to be inconsistent with a majority of the data. Their existence in the data during the analysis may cause a statistical analysis to be invalid or misleading.

Table 10 – Variables included in the Analysis, their Symbols, Types, and Units

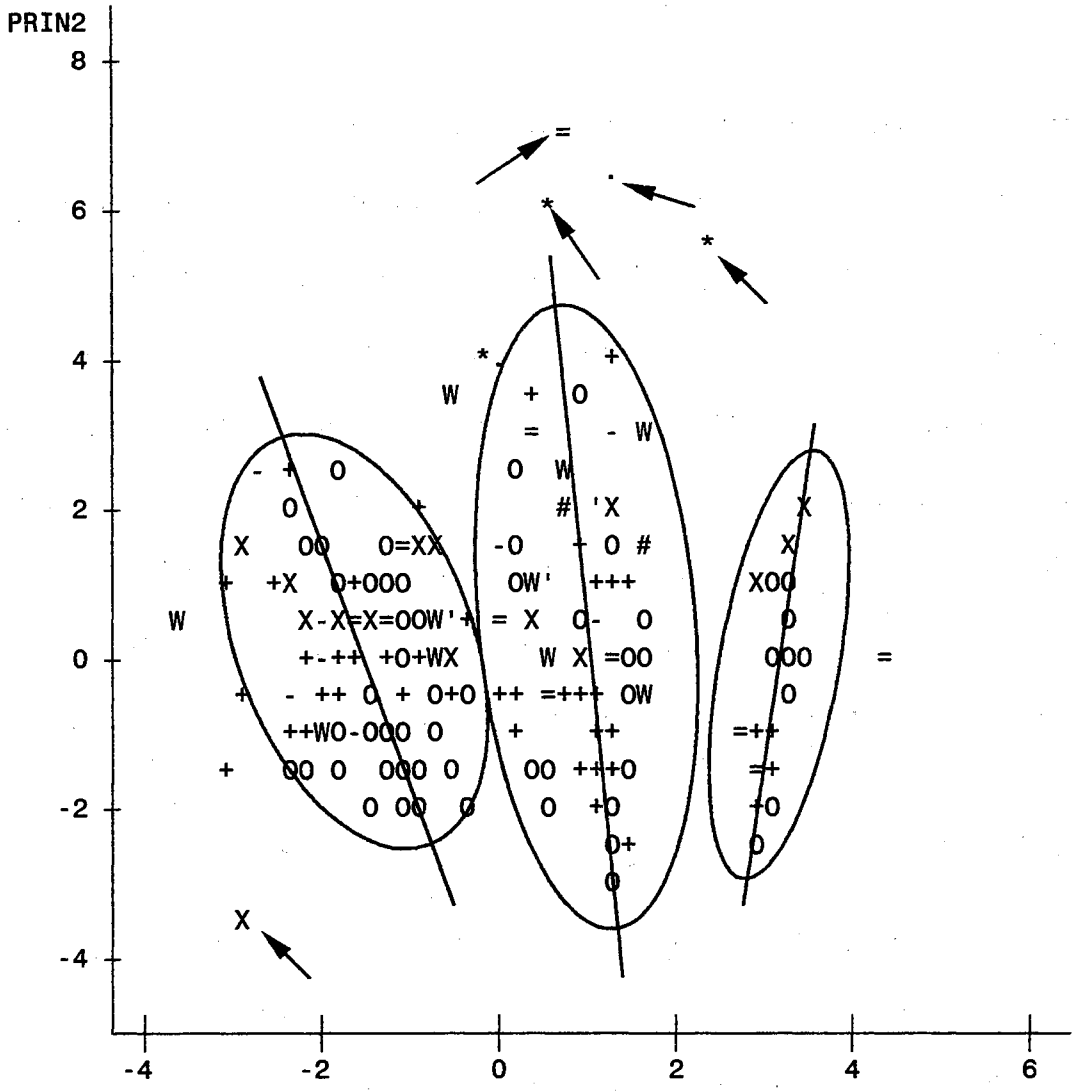
No.	Symbol	Variable	Type	Unit
1	x1	number of bids	numeric	numbers
2	x2	contract amount	numeric	$
3	x3	duration	numeric	calendar days
4	x4	number of projects	numeric	numbers
5	x5	bad weather days	numeric	calendar days
6	x6	ratio of bad weather days	numeric	ratio
7	x7	bidding environment	numeric	numbers
8	x8	timing of notice to proceed	numeric	calendar days
9	x9	number of projects with overrun	numeric	numbers
10	x10	ratio of projects with overrun	numeric	ratio
11	x11	average overrun	numeric	number (%)
12	x12	average cost growth	numeric	ratio
13	x13	unemployment rate	numeric	number (%)
14	x14	money left on table ratio	numeric	ratio
15	x15	bid range ratio	numeric	ratio
16	x16	contract difference ratio	numeric	ratio
17	x17	location	nonnumeric	-
18	x18	project type	nonnumeric	-
18	x19	contractor	nonnumeric	-
20	x20	resident engineer	nonnumeric	-
21	x21	unit system	nonnumeric	-
22	x22	existence of out-of-state firm	nonnumeric	-
23	Id	project identification number	numeric	-
24	Y	cost growth	numeric	ratio

Another reason for performing principal components analysis was to check the existence of multicollinearity among the predictor variables. Multicollinearity was checked and observed through the correlation matrix provided by SAS in the principal components procedure's output.

A procedure called PRINCOMP was used to perform the principal components analysis. The analysis was performed on the data, and a new set of data that contained values of the principal components scores was created. These new data contained all of the original data plus the principal component scores. Since 16 numeric variables were included in the analysis, 16 principal component scores were created and labeled PRIN1, PRIN2, PRIN3, ..., PRIN16. A blob-type plot of the first three principal component scores, shown in Figure 12, was created for examining the data included in the study and for checking the data for possible outliers.

An observation of the plot of the first three principal component scores shown in Figure 12 indicates no unusual data points. The points appear to fall into an elliptically shaped regions with major axes close to be parallel to the second principal component axes. The four points in the upper part and the one point in the lower left-hand corner of the plot could be outliers.

Appendix D shows a correlation matrix obtained by SAS during the analysis. It was used to check whether or not multicollinearity exists among variables included in the analysis. Several variables were found to be related. The related variables were identified and it was decided that this problem would be addressed during factor analysis.



Symbol	PRIN3	Symbol	PRIN3	Symbol	PRIN3
.....	-5 - -4	+++++	-1 - 0	*****	3 - 4
'''''	-4 - -3	00000	0 - 1	#####	4 - 5
-----	-3 - -2	XXXXX	1 - 2		
=====	-2 - -1	WWWWW	2 - 3		

Figure 12 – Blob Plot of the First Three Principal Component Scores

Factor Analysis

Factor analysis is a variable-directed technique to explain the correlation structure among the measured variables. It was performed on the 16 numeric variables of the data to overcome the multicollinearity problem by deriving, creating, and developing a new set of uncorrelated variables that could be used in future analyses of the data. When that set of factors was derived, there was a need to perform a factor rotation for a clearer interpretation. An important decision that needed to be made during factor analysis was the determination of the number of factors to be considered and included in the regression analysis during the process of developing the prediction model. Minimum eigenvalue, scree plot, and variation coverage were among the methods that could be used for that purpose.

The factor analysis process began with the FACTOR procedure considering the minimum eigenvalue criterion "MINEIGEN" to determine the number of factors to be included in the factor analysis. This method selects the number of factors by obtaining the principal components of all the numeric variables included in the analysis, ranking their eigenvalues starting with the greatest, then selecting the number of eigenvalues greater than one as the number of factors to include in the factor analysis. This method produced 7 factor groups to be included in the analysis, based on the 16 numeric variables and 266 observations.

Figure 13 shows a SCREE plot of the eigenvalues produced by the FACTOR procedure. This was the second method to determine the number of factor groups to be included in the analysis. The number of factor groups recommended by the scree plot

method was determined by taking the number of eigenvalues at which the line started to deflect and considering that number as the number of factor groups. On the graph, it was shown that either 5 or 6 could be considered as the number of factor groups. Both were taken as alternatives.

Variation coverage was the last method used to determine the number of factor groups needed to represent the 16 numeric variables in the analysis. Figure 14 represents the 16 eigenvalues obtained during the analysis with their proportion and cumulative coverages. The procedure was performed to establish a percent coverage and to select the number of eigenvalues that gives at least that target percentage. Eighty percent coverage was selected, and 8 was found to be the first number of factor groups at which the cumulative variation exceeded 0.80. Therefore, 8 factor groups were selected by this method to be included in the analysis.

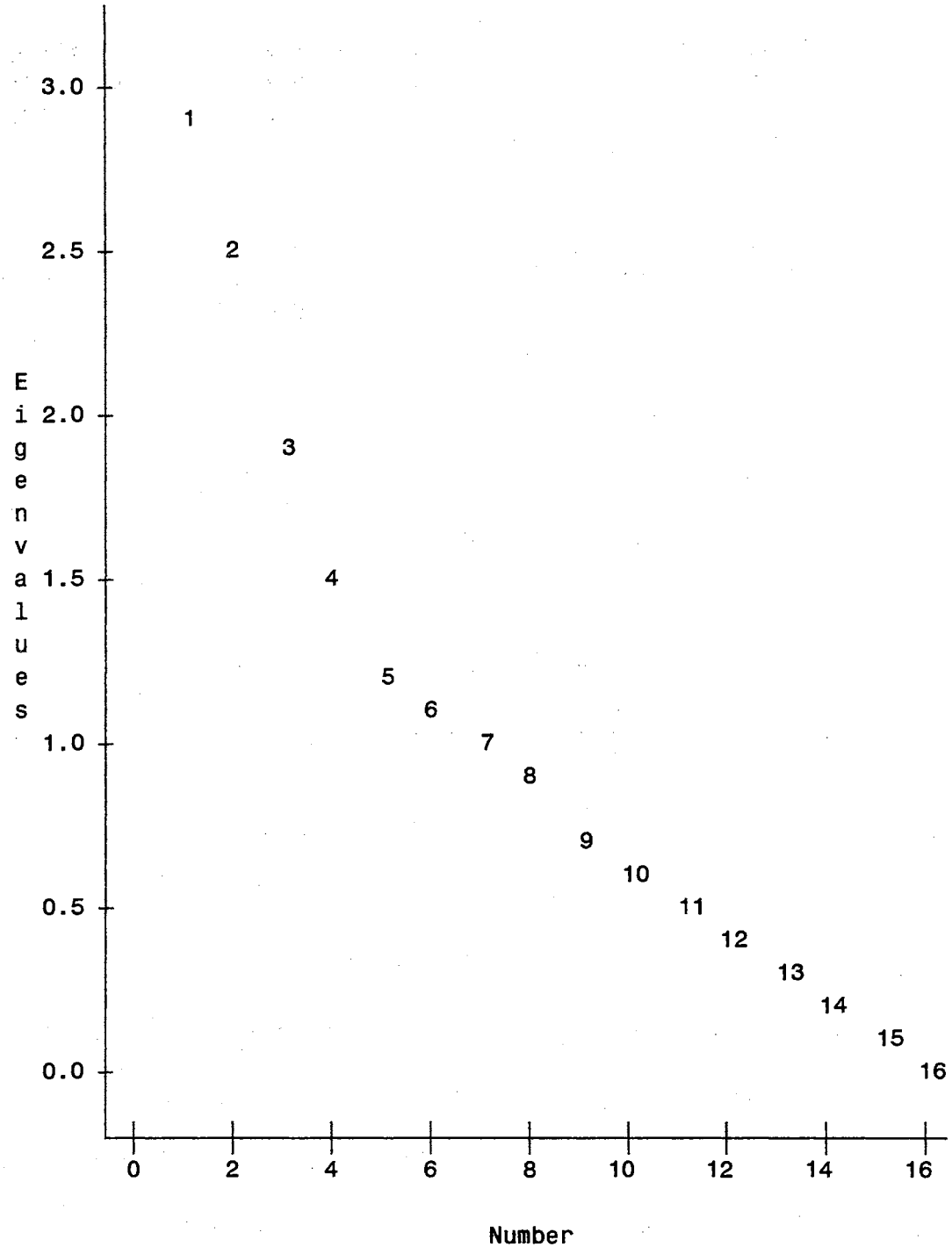


Figure 13 – Scree Plot of Eigenvalues

	1	2	3	4
Eigenvalue	2.9218	2.4849	1.8837	1.4621
Difference	0.4369	0.6012	0.4216	0.2133
Proportion	0.1826	0.1553	0.1177	0.0914
Cumulative	0.1826	0.3379	0.4556	0.5470

	5	6	7	8
Eigenvalue	1.2488	1.0656	1.0273	0.9147
Difference	0.1833	0.0383	0.1126	0.1895
Proportion	0.0781	0.0666	0.0642	0.0572
Cumulative	0.6251	0.6917	0.7559	0.8131

	9	10	11	12
Eigenvalue	0.7252	0.5940	0.5494	0.4329
Difference	0.1313	0.0446	0.1165	0.1424
Proportion	0.0453	0.0371	0.0343	0.0271
Cumulative	0.8584	0.8955	0.9298	0.9569

	13	14	15	16
Eigenvalue	0.2905	0.2395	0.1130	0.0467
Difference	0.0510	0.1265	0.0663	
Proportion	0.0182	0.0150	0.0071	0.0029
Cumulative	0.9750	0.9900	0.9971	1.0000

Figure 14 – Proportion and Cumulative Coverage of the Eigenvalues

As mentioned previously, a factor rotation procedure was needed in order to keep the factors uncorrelated. Several rotation procedures were considered. The Varimax procedure was selected because this procedure is commonly used in statistical analysis and it does not require iterative calculations.

In the three methods described previously, four different numbers of factor groups were recommended, 5, 6, 7, and 8. Table 11 is a summary of different methods used to determine the number of factor groups, number of factor groups recommended by each method, and variables included in each factor group.

Table 11 - Principal Factors Recommended by Factor Analysis and Variables Included

Method	No. of Factors	Variables included
I. Default	[7]	
(MINEIGEN)	10,11,12	(ratio of projects with overrun, average overrun, average cost growth)
	4,9	(number of projects, number of projects with overrun)
	5,6,7	(bad weather days, ratio of bad weather days, bidding environment)
	2,3	(contract amount, duration)
	1,16	(number of bids, contract difference ratio)
	14,15	(MLOT ratio, bid range ratio)
	8,13	(timing of Notice To Proceed, unemployment rate)
II. Scree 1	[6]	
	10,11,12	(ratio of projects with overrun, average overrun, average cost growth)
	4,9,14	(number of projects, number of projects with overrun, MLOT ratio)
	1,15,16	(number of bids, bid range ratio, contract difference ratio)
	2,3	(contract amount, duration)
	5,6,7	(bad weather days, ratio of bad weather days, bidding environment)
	8,13	(timing of Notice To Proceed, unemployment rate)
III. Scree 2	[5]	
	4,9,10,11,12	(no. of projects, no. of projects w/ overrun, ratio of projects w/ overrun, avg overrun, avg cost growth)
	1,3,5	(number of bids, duration, bad weather days)
	2,14,15,16	(contract amount, MLOT ratio, bid range ratio, contract difference ratio)
	6,7	(ratio of bad weather days, bidding environment)
	8,13	(timing of Notice To Proceed, unemployment rate)
IV. 80%	[8]	
(Variation Coverage)	10,11,12	(ratio of projects with overrun, average overrun, average cost growth)
	4,9	(number of projects, number of projects with overrun)
	5,6	(bad weather days, ratio of bad weather days)
	2,3	(contract amount, duration)
	1,16	(number of bids, contract difference ratio)
	14,15	(MLOT ratio, bid range ratio)
	8,13	(timing of work order, unemployment rate)
	7	(bidding environment)

After three different methods were applied in the factor analysis to determine the number of factor groups to be included in the regression analysis, a decision was required regarding which method to select. The interpretability and meaningfulness of the resultant groups were the major criteria considered in the decision process. As shown in Table 11, each method provided different factors containing different groups of variables. The minimum eigenvalue, scree plot 1, scree plot 2, and 80% coverage methods produced 7, 6, 5, and 8 factors respectively. In all the methods, the only agreement was found to be that variables x8 and x13 were grouped together. The other factor groups and the included variables were similar, but not the same. Scree plot 2 produced a grouping of variables that was somewhat different than the other 3 methods. The factor groups produced by the 80% variation coverage were found to be the most interpretable and meaningful grouping among the previously described methods. The resultant variable groups made the most theoretical and practical sense. Therefore, the 80% variation coverage was selected in the analysis.

Based on the 80% variation coverage, eight factor groups were chosen to represent the sixteen numeric variables in the regression analysis. Variables represented and contained within each factor are shown in Table 11. Table 12 shows the rotated factor-loading matrix for the eight-factor analysis. The framed numbers in each factor column represent the variables included in that particular factor. For example, numbers adjacent to x10, x11, and x12 in factor1 column are framed indicating that they are included in that factor.

Table 12 – Rotated Factor-Loading Matrix for Eight Factors

Variable	FACTOR1	FACTOR2	FACTOR3	FACTOR4
X1	0.14226	-0.05931	0.04705	0.00331
X2	0.03415	-0.03844	0.07420	0.80227
X3	0.09454	-0.03504	0.01776	0.87420
X4	0.09196	0.96167	-0.03967	-0.05058
X5	0.12173	-0.04238	0.81033	0.46998
X6	0.00052	-0.01528	0.94847	-0.10891
X7	0.01842	-0.04619	-0.07778	0.03487
X8	-0.09865	0.01085	-0.20700	0.01751
X9	0.34761	0.91430	-0.03099	-0.03808
X10	0.79868	0.15830	-0.01173	0.16259
X11	0.67092	0.43564	0.08636	-0.03017
X12	0.89696	0.06085	0.05128	0.04061
X13	0.09086	-0.08751	0.30165	0.08038
X14	-0.02594	-0.06537	0.01078	-0.07814
X15	0.12325	-0.11510	0.01265	0.04032
X16	0.00998	0.04795	-0.01077	-0.03921

Variable	FACTOR5	FACTOR6	FACTOR7	FACTOR8
X1	0.82107	-0.02518	0.10634	-0.07443
X2	-0.04510	-0.08800	0.00533	0.08430
X3	0.10011	0.03495	0.07824	-0.04263
X4	-0.09496	-0.08436	-0.05725	-0.00073
X5	0.05185	0.01110	0.04932	-0.09610
X6	0.03464	0.00727	0.00498	-0.02725
X7	0.01681	-0.02124	0.02283	0.98077
X8	0.11654	-0.06769	0.83096	-0.00102
X9	-0.04596	-0.05245	-0.00522	-0.04168
X10	0.19716	0.10304	0.08126	0.03730
X11	-0.07295	-0.06385	-0.06795	-0.14267
X12	0.04922	-0.00789	-0.04388	0.06470
X13	-0.07028	0.06308	0.77320	0.02915
X14	-0.04184	0.94754	-0.00962	0.00176
X15	0.54795	0.70298	-0.00179	-0.04737
X16	-0.76748	-0.09996	0.04680	-0.09246

Regression Analysis

Once the numeric variables were grouped into 8 meaningful factor groups, these factor groups were combined with the 6 nonnumeric variables. A stepwise multivariate regression analysis was then performed on the 14 variables based on the 266 observations, or projects. An examination of the results of the regression analysis showed that of the 14 variables included in the analysis, only factor groups 1 and 7 were found to be significant at the $\alpha = .10$ level. In other words, factor groups 1 and 7 were found to be statistically significant predictors of cost growth. On the other hand, R^2 was only 0.1078 which gave an indication that the regression was statistically significant but the relationship might not be of much practical importance.

Several attempts were made to improve the value of R^2. One of these attempts was based on reviewing the data and screening them for possible abnormal values. Eleven projects were found to have very high actual cost growth values compared with the others. It was decided to exclude them and perform the same analysis on the 255 remaining projects. A noticeable improvement resulted and the new results showed that factor groups 1, 4, 5, and variable x20 were significant at $\alpha = .10$ level with $R^2 = 0.3919$. This value of R^2 was the best that could be achieved through several trials and attempts.

Multiple regression analysis was then performed on the four significant variables; factor groups 1, 4, 5, and variable x20 based on the 255 observations.

Due to the fact that the variable x20, resident engineer, was a nonnumeric variable, there was a need to use dummy variables in order to be able to include it in the analysis. Because there were 44 levels (44 different resident engineers) in the variable

x20, 43 dummy variables were created, they were named d1, d2, d3, ..., d43. Each resident engineer was assigned a dummy variable. Each dummy variable takes the value of (1) with the existence of the resident engineer to whom it was assigned, and (zero) otherwise. The code used for this process is shown in the first two pages of Appendix E.

Multiple regression analysis was then performed on the data using the (REG) procedure. The parameter estimates for factor groups 1, 4, 5, and the dummy variables representing x20 were obtained and are presented in Chapter V.

Principal components analysis, factor analysis, and regression analysis were performed using the SAS system for Windows version 6.12. The SAS program and output for the analyses are shown in Appendices E and F respectively.

CHAPTER V

DATA ANALYSIS RESULTS

The Survey

As previously described in Chapters III and IV, responses of engineers' and contractors' questionnaires were used to obtain severity indices for each factor included in the questionnaires, reference Tables 5 and 6. The ranking process then started, and the degree of impact of each factor was determined, reference Table 7.

All 33 factors included in the questionnaires, except bid range and contract administration, were found to have impact on cost growth. Although it was found that bid range has no impact on cost growth, it was included in the analysis for the reasons specified in chapter IV.

Each factor that had an impact on cost growth was involved in the analysis and considered as a variable. Information related to 19 of the factors was found in ODOT's files on each project involved in the study, reference Table 8.

Two factors were excluded from the list of available factors shown in Table 8, and two other factors were replaced with seven new ones. Twenty-two factors were found to exist and needed to be included in the analysis as independent variables. Sixteen variables were numeric and the remaining 6 were non-numeric. The cost growth was

included in the analysis as the dependent variable. The final list of variables, their symbols, types, and units are shown in Table 10.

Consistency and Multicollinearity of the Data

A principal components analysis was performed on the numeric variables based on the 266 observations (projects) for two main reasons: to screen the data for possible outliers or inconsistency, and to check the existence of multicollinearity among the variables.

The analysis showed consistent data with nothing that appears to be too unusual. Very few points were found and identified as possible outliers. Multicollinearity was found to exist among some of the variables included in the analysis. Several variables were found to be related.

The problems of the outliers and the related variables were identified. They were dealt with in other phases of the analysis.

Factor Groups (Principal Factors)

Factor analysis was performed on the numeric variables to create a new set of uncorrelated variables that could be used in the regression analysis to develop the prediction model. The rotated factor-loading matrix shown in Chapter IV (Table 12) was used to establish the factor groups. The number of factor groups to be considered in the regression analysis representing the numeric variables in a form of independent and

uncorrelated variables was found to be eight. Table 13 represents the 8 factor groups, or principal factors, and the variables included, or represented, by each factor group.

Table 13 – The Selected Factor Groups, or Principal Factors, and Variables included

Factor Group (Principal Factor)	Variables included	
	Symbol	Name
1	x10	ratio of projects with overrun
	x11	average overrun
	x12	average cost growth
2	x4	number of projects
	x9	number of projects with overrun
3	x5	bad weather days
	x6	ratio of bad weather days
4	x2	contract amount
	x3	duration
5	x1	number of bids
	x16	contract difference ratio
6	x14	money-left-on-table ratio
	x15	bid range ratio
7	x8	timing of notice to proceed
	x13	unemployment rate
8	x7	bidding environment

Regression Analysis of the Cost Factors

The 8 principal factors resulting from the factor analysis were combined with the 6 non-numeric variables. Multiple regression analysis was then performed on the 14 variables. Table 14 gives the results of the regression analysis of those 14 variables.

Table 14 – Regression Analysis Results on the 14 Variables

Variable	F-value	P-value
Factor 1	41.17	**0.0001**
Factor 2	0.2	0.6538
Factor 3	0	0.9549
Factor 4	9.87	**0.0022**
Factor 5	3.05	**0.0841**
Factor 6	0	0.9486
Factor 7	1.39	0.2422
Factor 8	0.3	0.586
x17	1.2	0.2005
x18	0.44	0.643
x19	0.83	0.7579
x20	1.44	**0.0956**
x21	0	0.9611
x22	1.14	0.2884

As shown in Table 14, only factors 1, 4, 5, and variable x20 were found to be significant at $\alpha = .10$ level with R^2 equals 0.3919.

Multiple regression analysis was then performed on the four significant variables to obtain the parameter estimates. Since the variable x20, resident engineer, was a non-numeric variable, dummy variables were needed to include it as a variable in the analysis. Forty three dummy variables were created because of the 44 possible values of x20; they were named d1, d2, ..., d43. Table 15 gives the parameter estimates resulting from the regression analysis of the four significant variables. It should be noted that the variable x20 was replaced with the 43 previously described dummy variables; their estimates varied from –0.0380 to 0.0586 as shown in Appendix F (SAS Output).

The estimated standard error values were equal for all the regression factor groups, or principal factors, included in the analysis as variables because they were normalized and orthogonal.

Table 15 – Regression Analysis Results on the 4 Significant Variables

Variable	Parameter Estimate
Intercept	-0.0219
Factor 1	0.0161
Factor 4	0.0115
Factor 5	0.0043
x20	(-0.038 to 0.0586)

The Prediction Model

The multiple regression analysis that was performed on the four significant variables; factors 1, 4, 5, and the variable x20, produced the prediction model. Table 15 gives the parameter estimates for the following model:

$$Y = -0.0219 + R.E. + 0.0161*F1 + 0.0115*F4 + 0.0043*F5 \qquad \text{Equation 5.1}$$

where:

Y = the predicted cost change, in $

R. E. = number estimated according to resident engineers, as shown in Table 16

F1 = principal factor 1, calculated as shown in Table 17

F4 = principal factor 4, calculated as shown in Table 17

F5 = principal factor 5, calculated as shown in Table 17.

The predicted cost change, Y, in Equation 5.1 could be either positive or negative; the positive Y indicates a cost overrun while the negative Y indicates a cost underrun.

Table 16 – Values of R.E. in Equation 5.1

No.	Resident Engineer	R.E.	No.	Resident Engineer	R.E.
1	A	0.0447	23	V	-0.1117
2	B	0.0008	24	W	-0.0118
3	C	0.0049	25	X	0.0036
4	D	-0.0039	26	Y	0.0147
5	E	-0.0002	27	Z	0.0424
6	F	0.0586	28	Ab	0.0279
7	G	-0.0342	29	Ac	-0.0082
8	H	0.0270	30	Ad	-0.0087
9	I	-0.0129	31	Ae	-0.0106
10	J	0.0272	32	Af	0.0408
11	K	0.0154	33	Ag	0.0275
12	L	0.0258	34	Ah	0.0026
13	M	-0.0013	35	Ai	0.0188
14	N	0.0534	36	Aj	-0.0048
15	O	-0.0361	37	Ak	0.0143
16	P	0.0189	38	Al	0.0440
17	Q	-0.0380	39	Am	-0.0009
18	R	0.0015	40	An	0.0092
19	S	0.0348	41	Ao	0.0048
20	T	-0.0191	42	Ap	0.0376
21	As	0.0000	43	Aq	0.0035
22	U	0.0318	44	Ar	-0.0066

(Note: For resident engineers other than mentioned above, R.E. = 0.0074)

Table 17 – Calculation of Principal Factors in Equation 5.1

Principal Factor	Calculated as
F1	(0.79868)(x10) + (0.67092)(x11) + (0.89696)(x12)
F4	(0.80227)(x2) + (0.87420)(x3)
F5	(0.82107)(x1) - (0.76748)(x16)

where:

x10 = ratio of projects with overrun

x11 = average overrun, as a number (%)

x12 = average cost growth, as a ratio

x2 = contract amount, in $

x3 = duration, in calendar days

x1 = number of bids

x16 = contract difference ratio.

To illustrate the use of the prediction model, it was applied to four arbitrary selected paving projects. The first project had the following information:

- Number of bids (x1) = 3
- Contract amount (x2) = $149,181.50
- Duration (x3) = 137 days
- Ratio of projects in which the contract had overrun (x10) = 0.18
- Average overrun (x11) = 2.68 %
- Average cost growth (x12) = -0.04
- Contract difference ratio (x16) = -0.0287
- Resident engineer (x20) = An.

By substituting these values in Equation 5.1, the predicted cost change (Y) was found to be $1,377.77 which is equivalent to 0.92% of the contract amount. Actually, this project had a cost growth equivalent to 3%, which means that there is an agreement in identifying the occurrence of cost overrun.

The same thing was observed in the other three projects; they had actual cost changes equivalent to 12%, -2%, and -13%, while the predicted cost changes obtained by applying Equation 5.1 were found to be equivalent to 23%, -6%, and -30% respectively.

The difference between the actual and the predicted cost change amounts was expected. The value of R^2 obtained for the model from the analysis was 0.3919, which means that the relationship between the cost growth and the variables included in the model may not have any practical importance. On the other hand, the same relationship may have a statistical importance since the actual overruns were predicted as overruns and the underruns were predicted as underruns.

CHAPTER VI

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

A change in cost remains one of the most important issues for all of the parties involved in a construction project. Changes may occur due to several factors, some of which are related to each other. The main objectives of this research were to identify the factors that lead to cost changes, determine their influence or degree of impact on the cost changes, and develop a numerical model that predicts the amount of cost growth in ODOT paving projects using information available at bidding time based on the existence and the effectiveness of any of those factors.

For this research, factors that had impact on the cost changes in construction projects from previous studies were identified. Through several discussion sessions and meetings, other factors were added to the previous findings. All the factors were then combined to form the final list of 33 cost factors that were used in the analysis.

Two questionnaires, one for ODOT engineers and the other for ODOT contractors, were developed. The objective was to obtain the participants' responses as to whether or not the 33 cost factors have an impact on the cost growth and the degree of impact. Two hundred and three questionnaires were sent by mail to participants, 44 to engineers and 159 to contractors. The response rate to the engineers' and contractors'

questionnaires was 61.36% and 31.45% respectively. A simple analysis was performed on the responses to determine the impact that each factor has on cost growth.

All factors that had impact on the cost growth as obtained from participants' responses to both questionnaires were involved in the analysis process. Each factor was considered a variable. Of the 33 factors that were found to be important, information related to 19 were obtainable in ODOT files. Information on the remaining 14 factors was not available, and therefore these factors were not included in the analysis.

Specific criteria were established for selecting the projects in order to meet the scope of this research. The criteria included ODOT paving projects costing less than $5 million that were completed between 1995 and 1998. Two hundred sixty six projects met those criteria. For each project included in the analysis, there was input for each one of the 19 available factors (variables). Other variables were obtained by performing simple calculations on the available information in the project files. Twenty-two factors, 16 numeric and 6 nonnumeric, were found to exist and included in the analysis as variables.

Principal components analysis was performed on the 16 numeric variables to screen the data for outliers and to check the existence of multicollinearity among the predictor variables. Very few outliers were observed, and several variables were found to be related.

Factor analysis was performed on the numeric variables to overcome the multicollinearity problem by deriving, creating, and developing a new set of uncorrelated variables that could be used in the analysis. Eight factor groups (principal factors) were chosen to represent the 16 numeric variables in the final analysis which was the regression analysis. Table 12 presents the selected factor groups and variables included.

After the numeric variables were grouped into 8 meaningful groups (principal factors), they were combined with the 6 non-numeric variables. A multivariate regression analysis was then performed on the 14 variables based on the 266 observations (projects) as a first step in developing the prediction model. After several attempts were made to improve the value of R^2, factors 1, 4, 5, and variable x20 were found to be significant at $\alpha = .10$ level with $R^2 = 0.3919$.

Including only significant variables, multiple regression analysis was then performed on the data to formulate the prediction model and to obtain the parameter estimates for the variables involved. Table 14 shows the regression analysis results (parameter estimates), and Equation 5.1 represents the resulting prediction model. The model was then applied to four arbitrary selected paving projects. There was an agreement in identifying the occurrence of cost changes between the actual cost changes and those obtained by the prediction model. In other words, the actual overruns were obtained (predicted) using the prediction equation as overruns and the actual underruns were obtained (predicted) as underruns. A difference was found between the actual and the predicted cost change amounts, which explained the fact that the relationship between the cost growth and the variables included in the model might have a statistical but not a practical importance.

More details about the data analysis techniques and statistics are shown in Chapter IV, while Chapter V provides extensive explanation of the data analysis results for different phases of the research.

Conclusions

Thirty-three factors were found to have impact on cost growth in ODOT paving projects. Of these 33 cost factors, 22 were related to ODOT engineers, 28 to contractors, and 17 to both groups. The factors and their degree of impact on cost growth were obtained from participants' responses to the questionnaires. The factors were ranked according to their impact on the cost growth; "Project size" was ranked first by the engineers and "Availability of labor" was ranked first by the contractors. Table 7 represents the 33 cost factors, their impact, and ranking.

Information related to 19 of the factors (variables) was found in ODOT files on each project involved in the study, reference Table 8. Two factors were excluded and two factors were replaced with seven new factors that were added to the list, which resulted in 22 cost factors that were included in the analysis as independent variables. Project identification number and the dependent variable (Y) were added to the list resulting in a final list of 24 variables, reference Table 10.

Principal factors 1, 4, 5, and "Resident engineer" represent 8 of the variables that were found to be significant in predicting the amount of cost growth, reference Table 14. As shown in Table 13, "Ratio of projects with overrun", "Average overrun", and "Average cost growth", which are all related to contractors and specifically their history of cost overrun, are included in principal factor 1. On the other hand, "Contract amount" and "Duration", which are related to project size, are included in principal factor 4. Also, "Number of bids" and "Contract difference ratio", which are related to the bidding environment, are included in principal factor 5. Thus, 8 of the 22 independent and

available cost factors are predictor variables. In other words, contractor, project size, bidding environment, and resident engineer were found to have significant impact on the cost growth and are significant in predicting the cost growth in ODOT paving projects.

Also, based on the previous explaination and the P-values obtained in the analysis, reference Table 14, it can be concluded that "contractor" was found to have the most impact on cost growth followed by "project size", "bidding environment", and "resident engineer" respectively.

Table 18 presents a summary of the elements found to have an impact on cost growth and the included factors (the predictor variables).

Table 18 – Elements influencing Cost Growth and Factors included

Contractor	Project Size	Bidding Environment	Resident Engineer
ratio of projects with overrun average overrun average cost growth	contract amount duration	number of bids contract difference ratio	resident engineer

The numerical prediction model that was developed based on those variables to predict the amount of cost growth in ODOT paving projects using information available at the bidding time is shown in Equation 5.1.

Recommendations

During this research, a variety of topics and points for further evaluation and investigation were identified. These topics include the following:

- Investigate cost growth in public projects in general.
- Include ODOT projects other than paving.
- Study cost growth and causation factors during construction.
- Conduct a study of cost growth regardless of size and contract amount.
- Consider the inflation rates during the analysis of previous projects and while developing the prediction model.
- Include personal interviews as a data collection method.
- Define more precisely each factor included in the questionnaires.
- Begin the survey with a guide (pilot) questionnaire.
- Evaluate the factors which are found to be unavailable in ODOT files at the bidding time.
- Include more paving projects in the study and applying the developed model to every project involved in the study.

These topics and areas are recommended for further research.

The research was restricted to ODOT projects which makes the findings applicable only to ODOT projects. Further research is needed to include all public projects.

The selection of projects to be involved in the research was based on several criteria. Projects needed to be paving projects at a specific time (January 1995 to

December 1998) and contract amount (less than 5 million dollars). Further research should include projects other than paving projects. Also, timing and size (contract amount) of projects should not be limited so that the finding would be widely applicable.

The research identified the factors that affect cost growth at the bidding time and their impact. Further research should consider the factors that affect the cost growth during construction.

While analyzing data and developing the prediction model, inflation and interest rates were not included. Further research should include them.

The survey used in the research was conducted through self-administered questionnaires which involved sending questionnaires and collecting the participants' responses by mail. Several telephone calls were received regarding the meaning and the wording of some factors. Therefore, it would be more appropriate in further research to consider the method of personal interviews as a data collection method.

Factors included in the questionnaires were written without detailed definitions and explanations. Statements defining and explaining factors included in the questionnaires would be helpful in understanding them; this might lead to more precise answers and better response rates in further research.

Although engineers' and contractors' questionnaires were designed through several discussion sessions with ODOT engineers and committee members, it was realized that starting the survey with a guide questionnaire would give the participants better understanding and provide the research with valuable inputs. This is also recommended for further research.

While collecting project data on the factors which were determined from participants' responses, information related to 14 cost factors was found to be unavailable in ODOT file, reference Table 8. These 14 factors were excluded from portions of the analysis. Since some of those factors were believed to be significant and may have an impact on the cost growth, further research is recommended to investigate those factors and collect information related to them to make them available in all of the analysis phases.

Since the prediction model was developed in this study including significant factors at $\alpha = .10$ level with $R^2 = 0.3919$, further research is recommended to include more projects in order to improve the statistical importance of the model. Also, the model needs to be applied to a larger number of projects to check its practical importance.

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APPENDICES

APPENDIX A

IRB APPROVAL FORM

OKLAHOMA STATE UNIVERSITY
INSTITUTIONAL REVIEW BOARD

Date:	October 29, 1999	IRB #: EG-00-002
Proposal Title:	"PREDICTING CONSTRUCTION COST GROWTH IN ODOT'S PAVING PROJECTS USING INFORMATION AVAILABLE AT THE BIDDING TIME"	
Principal Investigator(s):	Garold Oberlender Bassam Ghulman	
Reviewed and Processed as:	Exempt	

Approval Status Recommended by Reviewer(s): Approved

Signature:

Carol Olson

Carol Olson, Director of University Research Compliance

October 29, 1999
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modification to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

APPENDIX B

THE QUESTIONNAIRES COVER LETTER

OKLAHOMA STATE UNIVERSITY

OSU

College of Engineering, Architecture and Technology
Civil and Environmental Engineering
207Engineering South
Stillwater, Oklahoma 74078-5033
405-744-5189
Fax 405-744-7554

Dear Participant:

The attached survey form has been prepared to identify indicators of cost growth of paving projects. It is a part of an academic research project that is being conducted by a Ph.D. candidate at Oklahoma State University, and named "Predicting Construction Cost Growth in ODOT's Paving Projects Using Information Available at the Bidding Time".

The purpose of the research is to evaluate a number of completed construction projects that had cost changes and study the existence of different causing factors. A statistical model to predict the amount of cost over/under run is to be developed. Determining the existence, influence and effectiveness of each cost factor affecting the cost growth may lead to better control on construction cost and help in looking for possible solutions to avoid the expected cost growth.

You have been selected to participate in this survey. The information you supply will be held in **strict confidence**. At no time will you be identified in the research results. The only persons who will have access to the survey forms are the researchers, who will summarize the survey forms of all respondents.

Please complete the attached questionnaire and return it through one of the following ways:
- Use the attached postage-paid self-addressed envelope, or
- Fax it to (405) 747-2211.

Thank you for taking the time to participate in our research. If you have any questions about the research, your participation or rights, please contact:
- **Bassam Ghulman** [Phone: (405) 744-1025, E-Mail: ghulman@okstate.edu],
- **Dr. Garold D. Oberlender** [Phone: (405) 744-5260, E-Mail : oberlender@aol.com], or
- **Sharon Bacher**, IRB Executive Secretary, Oklahoma State University, 203 Whitehurst, Stillwater, OK 74078 [Phone: (405) 744-5700].

Sincerely,

Bassam Ghulman
Ph.D. Candidate in Civil Engineering

APPENDIX C

PROJECT DATA

ID	Project No	Location (County)	Project Type	Letting Date	Number of Bids
1	9(317)	Canadian	Resurfacing	2/22/96	3
2	52(241)	Noble	Resurfacing	4/20/95	2
3	52(242)	Noble	Resurfacing	4/20/95	2
4	53(133)	Nowata	Resurfacing	6/22/95	2
5	54(134)	Okfuskee	Surfacing	4/25/96	0
6	54(178)	Okfuskee	Surfacing	3/23/95	3
7	54(180)	Okfuskee	Overlay	3/23/95	4
8	55(877)	Oklahoma	Resurfacing	4/20/95	6
9	55(878)	Oklahoma	Resurfacing	4/20/95	6
10	55(915)	Oklahoma	Resurfacing	1/25/96	6
11	55(919)	Oklahoma	Overlay	1/25/96	0
12	55(979)	Oklahoma	Resurfacing	4/25/96	0
13	55(980)	Oklahoma	Resurfacing	4/25/96	3
14	56(256)	Okmulgee	Resurfacing	5/25/95	3
15	56(261)	Okmulgee	Resurfacing	8/24/95	3
16	57(359)	Osage	Overlay	3/23/95	2
17	57(362)	Osage	Resurfacing	6/22/95	2
18	57(369)	Osage	Overlay	3/23/95	5
19	44-2(372)	Tulsa	Resurfacing	4/24/97	3
20	44(292)	McClain	Resurfacing	3/23/95	5
21	44(347)	McClain	Resurfacing	4/20/95	6
22	45(315)	McCurtain	Resurfacing	6/22/95	2
23	45(324)	McCurtain	Resurfacing	6/20/96	3
24	46(231)	Mcintosh	Resurfacing	1/25/96	3
25	46(240)	Mcintosh	Resurfacing	7/27/95	3
26	46(234)	Mcintosh	Overlay	1/26/95	3
27	47(134)	Major	Overlay	3/23/95	1
28	48(188)	Marshall	Resurfacing	2/23/95	4
29	49(327)	Mayes	Overlay	3/23/95	4
30	50(160)	Murray	Resurfacing	6/22/95	2
31	50(164)	Murray	Resurfacing	4/25/96	0
32	51(421)	Muskogee	Resurfacing	3/21/96	3
33	51(403)	Muskogee	Surfacing	10/26/95	3
34	51(399)	Muskogee	Resurfacing	9/14/95	4
35	51(422)	Muskogee	Resurfacing	4/25/96	2
36	51(413)	Muskogee	Resurfacing	8/24/95	3
37	51(410)	Muskogee	Resurfacing	4/24/97	3
38	39(190)	Latimer	Resurfacing	6/20/96	1
39	40-4(347)	Canadian	Resurfacing	3/21/96	4
40	40-5(30)	Oklahoma	Resurfacing	2/23/95	2
41	40(402)	LeFlore	Resurfacing	10/26/95	2
42	40(429)	LeFlore	Resurfacing	6/20/96	1
43	41(235)	Lincoln	Resurfacing	5/25/95	2
44	41(289)	Lincoln	Resurfacing	4/20/95	3
45	41(288)	Lincoln	Resurfacing	4/20/95	4
46	41(311)	Lincoln	Resurfacing	4/25/96	4

ID	Lowest Bid	2nd Lowest Bid	Highest Bid	MLOT	Bid Range
1	$149,181.50	$152,760.10	$209,604.40	$3,578.60	$60,422.90
2	$313,700.00	$337,400.50	$337,400.50	$23,700.50	$23,700.50
3	$565,917.65	$605,692.50	$605,692.50	$39,774.85	$39,774.85
4	$870,893.75	$1,028,527.00	$1,028,527.00	$157,633.25	$157,633.25
5	$0.00	$0.00	$0.00	$0.00	$0.00
6	$342,922.15	$388,751.00	$405,192.83	$45,828.85	$62,270.68
7	$131,001.20	$132,796.40	$0.00	$1,795.20	($131,001.20)
8	$425,655.00	$458,445.00	$957,100.00	$32,790.00	$531,445.00
9	$42,375.00	$54,260.76	$74,462.50	$11,885.76	$32,087.50
10	$136,167.34	$151,776.73	$334,988.90	$15,609.39	$198,821.56
11	$0.00	$0.00	$0.00	$0.00	$0.00
12	$0.00	$0.00	$0.00	$0.00	$0.00
13	$549,157.00	$552,976.00	$653,604.00	$3,819.00	$104,447.00
14	$268,726.40	$272,872.50	$294,519.10	$4,146.10	$25,792.70
15	$216,896.40	$232,908.20	$264,152.40	$16,011.80	$47,256.00
16	$252,520.00	$349,475.00	$349,475.00	$96,955.00	$96,955.00
17	$703,170.00	$1,171,630.00	$1,171,630.00	$468,460.00	$468,460.00
18	$849,444.00	$983,494.85	$1,076,315.00	$134,050.85	$226,871.00
19	$643,280.04	$694,021.75	$1,033,593.45	$50,741.71	$390,313.41
20	$61,863.20	$63,015.80	$65,861.20	$1,152.60	$3,998.00
21	$207,588.25	$209,879.90	$313,001.25	$2,291.65	$105,413.00
22	$487,762.00	$490,003.20	$490,003.20	$2,241.20	$2,241.20
23	$494,464.00	$495,526.80	$532,460.00	$1,062.80	$37,996.00
24	$163,662.00	$168,224.50	$183,043.50	$4,562.50	$19,381.50
25	$255,885.00	$256,863.00	$307,550.00	$978.00	$51,665.00
26	$129,900.00	$144,452.50	$148,512.00	$14,552.50	$18,612.00
27	$308,292.08	$308,292.08	$308,292.08	$0.00	$0.00
28	$118,123.35	$127,305.50	$143,135.65	$9,182.15	$25,012.30
29	$306,246.40	$336,277.00	$375,527.50	$30,030.60	$69,281.10
30	$486,327.65	$677,047.50	$677,047.50	$190,719.85	$190,719.85
31	$0.00	$0.00	$0.00	$0.00	$0.00
32	$539,665.10	$549,567.55	$584,925.10	$9,902.45	$45,260.00
33	$169,921.00	$181,580.00	$230,951.15	$11,659.00	$61,030.15
34	$138,112.65	$144,356.18	$160,483.98	$6,243.53	$22,371.33
35	$255,376.00	$276,026.00	$276,026.00	$20,650.00	$20,650.00
36	$23,163.00	$28,313.00	$36,054.40	$5,150.00	$12,891.40
37	$222,697.23	$274,117.92	$322,989.32	$51,420.69	$100,292.09
38	$156,761.00	$156,761.00	$156,761.00	$0.00	$0.00
39	$3,566,952.95	$3,575,881.49	$4,796,198.53	$8,928.54	$1,229,245.58
40	$1,312,190.14	$1,623,316.80	$1,623,316.80	$311,126.66	$311,126.66
41	$318,207.50	$371,334.00	$371,334.00	$53,126.50	$53,126.50
42	$471,757.90	$471,757.90	$471,757.90	$0.00	$0.00
43	$122,475.20	$125,131.30	$125,131.30	$2,656.10	$2,656.10
44	$444,213.60	$457,217.30	$593,360.60	$13,003.70	$149,147.00
45	$668,714.32	$761,910.00	$866,336.00	$93,195.68	$197,621.68
46	$697,812.95	$726,295.37	$760,425.82	$28,482.42	$62,612.87

ID	Engr's Estimate	Contract Amount	Contract Difference	Actual Cost	Cost Growth
1	$153,465.50	$149,181.50	($4,284.00)	$142,750.18	-4.31%
2	$358,613.25	$313,700.00	($44,913.25)	$297,595.12	-5.13%
3	$446,668.75	$565,917.65	$119,248.90	$565,916.55	0.00%
4	$810,505.00	$870,893.75	$60,388.75	$870,491.17	-0.05%
5	$0.00	$261,618.90	$261,618.90	$256,230.84	-2.06%
6	$345,217.75	$342,922.15	($2,295.60)	$341,789.16	-0.33%
7	$128,667.00	$131,001.20	$2,334.20	$131,462.47	0.35%
8	$549,590.00	$425,655.00	($123,935.00)	$425,655.00	0.00%
9	$73,400.00	$42,375.00	($31,025.00)	$44,242.73	4.41%
10	$208,369.46	$136,167.34	($72,202.12)	$138,001.33	1.35%
11	$0.00	$722,845.00	$722,845.00	$710,501.86	-1.71%
12	$0.00	$1,588,096.50	$1,588,096.50	$1,658,614.91	4.44%
13	$659,995.00	$549,157.00	($110,838.00)	$491,882.95	-10.43%
14	$263,484.50	$268,726.40	$5,241.90	$253,263.31	-5.75%
15	$0.00	$216,896.40	$216,896.40	$212,208.63	-2.16%
16	$242,150.00	$252,520.00	$10,370.00	$249,187.76	-1.32%
17	$632,170.00	$703,436.50	$71,266.50	$695,150.56	-1.18%
18	$828,160.00	$849,444.00	$21,284.00	$840,714.13	-1.03%
19	$768,345.45	$643,280.04	($125,065.41)	$597,518.15	-7.11%
20	$65,237.40	$61,863.20	($3,374.20)	$54,375.72	-12.10%
21	$202,587.00	$207,588.25	$5,001.25	$209,055.42	0.71%
22	$402,047.10	$487,762.00	$85,714.90	$466,577.38	-4.34%
23	$491,930.00	$494,464.00	$2,534.00	$473,850.69	-4.17%
24	$178,743.00	$163,662.00	($15,081.00)	$158,993.94	-2.85%
25	$258,262.50	$255,885.00	($2,377.50)	$251,062.69	-1.88%
26	$147,410.00	$129,900.00	($17,510.00)	$129,278.79	-0.48%
27	$291,035.30	$308,292.08	$17,256.78	$306,221.23	-0.67%
28	$126,093.00	$118,123.35	($7,969.65)	$116,669.38	-1.23%
29	$311,362.00	$306,246.40	($5,115.60)	$304,843.19	-0.46%
30	$531,474.25	$486,327.65	($45,146.60)	$463,820.87	-4.63%
31	$0.00	$323,778.50	$323,778.50	$316,687.07	-2.19%
32	$536,394.50	$539,665.10	$3,270.60	$541,259.45	0.30%
33	$168,159.00	$169,921.00	$1,762.00	$172,690.37	1.63%
34	$136,863.80	$138,112.65	$1,248.85	$165,148.68	19.58%
35	$293,835.00	$255,376.00	($38,459.00)	$314,775.86	23.26%
36	$0.00	$23,163.00	$23,163.00	$23,037.82	-0.54%
37	$280,290.49	$222,697.23	($57,593.26)	$218,100.68	-2.06%
38	$159,720.00	$156,761.00	($2,959.00)	$156,362.26	-0.25%
39	$4,264,912.25	$3,426,952.95	($837,959.30)	$3,458,463.59	0.92%
40	$1,202,432.20	$1,312,190.14	$109,757.94	$1,016,289.11	-22.55%
41	$285,488.00	$318,207.50	$32,719.50	$317,174.14	-0.32%
42	$476,178.00	$471,757.90	($4,420.10)	$469,524.51	-0.47%
43	$112,713.50	$122,475.20	$9,761.70	$119,335.38	-2.56%
44	$446,112.00	$444,213.60	($1,898.40)	$441,442.50	-0.62%
45	$685,544.00	$668,714.32	($16,829.68)	$666,946.47	-0.26%
46	$774,408.00	$697,812.95	($76,595.05)	$688,880.23	-1.28%

ID	Duration	Contractor	Number of Projects
1	137	Haskell Lemon Construction Co.	11
2	45	Evans & Associates Const.	4
3	62	Evans & Associates Const.	4
4	68	Bellco Materials, Inc.	16
5	60	Glover Construction Co., Inc.	30
6	90	Shawnee Asphalt Company	6
7	90	Glover Construction Co., Inc.	30
8	654	Edmond Paving & Const. Co.	3
9	58	Edmond Paving & Const. Co.	3
10	242	Shell Const. Co., Inc.	2
11	110	Shears Construction Co.	19
12	94	Haskell Lemon Construction Co.	11
13	157	Haskell Lemon Construction Co.	11
14	73	Glover Construction Co., Inc.	30
15	271	APAC-Oklahoma, Inc.	7
16	58	Bellco Materials, Inc.	16
17	61	Bellco Materials, Inc.	16
18	131	Bellco Materials, Inc.	16
19	113	APAC-Oklahoma, Inc.	7
20	40	Silver Star Truck Lines, Inc.	2
21	45	Shawnee Asphalt Company	6
22	184	Glover Construction Co., Inc.	30
23	177	Glover Construction Co., Inc.	30
24	87	Glover Construction Co., Inc.	30
25	62	Glover Construction Co., Inc.	30
26	125	Glover Construction Co., Inc.	30
27	62	The Cummins Construction Co., Inc.	35
28	83	The Cummins Construction Co., Inc.	35
29	52	Bellco Materials, Inc.	16
30	137	Broce Const. Co., Inc.	18
31	169	Broce Const. Co., Inc.	18
32	40	Glover Construction Co., Inc.	30
33	312	Glover Construction Co., Inc.	30
34	219	Glover Construction Co., Inc.	30
35	83	Glover Construction Co., Inc.	30
36	74	Tiger Ind. Transp. Sys., Inc.	4
37	171	Tiger Ind. Transp. Sys., Inc.	4
38	46	Job Construction Co., Inc.	12
39	296	Haskell Lemon Construction Co.	11
40	272	T. J. Campbell Const. Co.	3
41	212	Job Construction Co., Inc.	12
42	45	Job Construction Co., Inc.	12
43	45	Shawnee Asphalt Company	6
44	60	Masters-Jackson Paving Co.	2
45	60	Shawnee Asphalt Company	6
46	130	The Cummins Construction Co., Inc.	35

ID	Total Cost Growth	Resident Engineer	Weather	No of Bad Weather Days
1	-0.48	an	No	0
2	-0.15	ah	No	0
3	-0.15	ah	No	0
4	0.33	am	No	0
5	0.72	l	No	0
6	-0.03	l	No	0
7	0.72	l	No	0
8	0.05	e	Yes	94
9	0.05	a	Yes	22
10	0.07	e	Yes	61
11	-0.21	q	Yes	61
12	-0.48	e	Yes	27
13	-0.48	q	Yes	37
14	0.72	b	No	0
15	-0.31	b	Yes	56
16	0.33	ae	Yes	56
17	0.33	ae	No	0
18	0.33	ae	No	0
19	-0.31	o	No	0
20	-0.15	p	No	0
21	-0.03	s	Yes	38
22	0.72	t	No	0
23	0.72	d	No	0
24	0.72	b	Yes	58
25	0.72	b	No	0
26	0.72	b	Yes	61
27	-0.57	r	No	0
28	-0.57	ag	No	0
29	0.33	am	Yes	56
30	-0.35	ac	No	0
31	-0.35	ad	Yes	37
32	0.72	b	Yes	37
33	0.72	b	Yes	61
34	0.72	b	Yes	50
35	0.72	b	No	0
36	-0.05	b	No	0
37	-0.05	aj	No	0
38	-0.09	y	No	0
39	-0.48	ar	Yes	61
40	-0.31	q	Yes	61
41	-0.09	y	No	0
42	-0.09	u	No	0
43	-0.03	l	No	0
44	-0.02	l	Yes	37
45	-0.03	l	No	0
46	-0.57	l	No	0

ID	Bad weather Days Ratio	Bidding Environment	Plans Review Time	Unit System
1	0.00003		21	English-Metric
2	0.000027		21	English
3	0.000027		21	English
4	0.000021		21	English
5	0.000016		21	English-Metric
6	0.000020		21	English
7	0.000020		21	English
8	0.143727		21	English
9	0.379327		21	English
10	0.25216		21	English-Metric
11	0.55456		21	English-Metric
12	0.287216		21	English-Metric
13	0.235716		21	English-Metric
14	0.000012		21	English
15	0.20666		21	English
16	0.965520		21	English
17	0.000021		21	English
18	0.000020		21	English
19	0.000011		21	English-Metric
20	0.000020		21	English
21	0.844427		21	English
22	0.000021		21	English
23	0.000026		21	English-Metric
24	0.66676		21	English-Metric
25	0.00004		21	English
26	0.48805		21	English
27	0.000020		21	English
28	0.00009		21	English
29	1.076920		21	English
30	0.000021		21	English
31	0.218916		21	English-Metric
32	0.925011		21	English-Metric
33	0.19553		21	English
34	0.22831		21	English
35	0.000016		21	English-Metric
36	0.00006		21	English
37	0.000011		21	English-Metric
38	0.000026		21	English-Metric
39	0.206111		21	English-Metric
40	0.22439		21	English
41	0.00003		21	English
42	0.000026		21	English-Metric
43	0.000012		21	English
44	0.616727		21	English
45	0.000027		21	English
46	0.000016		21	English-Metric

ID	Out-of-State Firms	Work Order Date	Timing of Work Order	Contractors History
1	No	4/26/96	64	Yes
2	No	5/23/95	33	No
3	No	5/23/95	33	No
4	No	8/2/95	41	Yes
5	No	6/10/96	46	Yes
6	No	5/26/95	64	Yes
7	No	3/23/95	0	Yes
8	No	5/26/95	36	Yes
9	No	5/22/95	32	Yes
10	No	2/26/96	32	Yes
11	No	2/29/96	35	Yes
12	No	6/3/96	39	Yes
13	No	5/23/96	28	Yes
14	No	6/30/95	36	Yes
15	No	10/4/95	41	Yes
16	No	5/4/95	42	Yes
17	Yes	8/8/95	47	Yes
18	No	5/4/95	42	Yes
19	No	6/5/97	42	Yes
20	No	5/12/95	50	No
21	No	5/22/95	32	Yes
22	No	8/4/95	43	Yes
23	Yes	7/29/96	39	Yes
24	No	4/26/96	92	Yes
25	No	8/22/95	26	Yes
26	No	3/6/95	39	Yes
27	No	4/19/95	27	Yes
28	No	6/15/95	112	Yes
29	Yes	5/4/95	42	Yes
30	No	7/19/95	27	Yes
31	No	5/23/96	28	Yes
32	No	4/18/96	28	Yes
33	Yes	12/1/95	36	Yes
34	No	11/7/95	54	Yes
35	No	5/23/96	28	Yes
36	No	10/3/95	40	No
37	Yes	6/26/97	63	No
38	No	7/25/96	35	No
39	No	4/25/96	35	Yes
40	No	3/27/95	32	No
41	No	12/1/95	36	No
42	No	7/25/96	35	No
43	No	7/18/95	54	Yes
44	No	5/23/95	33	No
45	No	5/26/95	36	Yes
46	No	6/6/96	42	Yes

ID	Projects with Overrun	Average No of Projects with O/R	Average Overrun
1	2	0.1818	2.6800
2	0	0.0000	0.0000
3	0	0.0000	0.0000
4	5	0.3125	9.2540
5	11	0.3667	14.2400
6	1	0.1667	0.7100
7	11	0.3667	14.2400
8	2	0.6667	2.3100
9	2	0.6667	2.3100
10	2	1.0000	3.2700
11	3	0.1579	7.2733
12	2	0.1818	2.6800
13	2	0.1818	2.6800
14	11	0.3667	14.2400
15	1	0.1429	1.2200
16	5	0.3125	9.2540
17	5	0.3125	9.2540
18	5	0.3125	9.2540
19	1	0.1429	1.2200
20	0	0.0000	0.0000
21	1	0.1667	0.7100
22	11	0.3667	14.2400
23	11	0.3667	14.2400
24	11	0.3667	14.2400
25	11	0.3667	14.2400
26	11	0.3667	14.2400
27	10	0.2857	2.8000
28	10	0.2857	2.8000
29	5	0.3125	9.2540
30	1	0.0556	1.9000
31	1	0.0556	1.9000
32	11	0.3667	14.2400
33	11	0.3667	14.2400
34	11	0.3667	14.2400
35	11	0.3667	14.2400
36	0	0.0000	0.0000
37	0	0.0000	0.0000
38	0	0.0000	0.0000
39	2	0.1818	2.6800
40	0	0.0000	0.0000
41	0	0.0000	0.0000
42	0	0.0000	0.0000
43	1	0.1667	0.7100
44	0	0.0000	0.0000
45	1	0.1667	0.7100
46	10	0.2857	2.8000

ID	Average Cost Growth	Availability of Labor
1	-0.0436	5
2	-0.0375	4.6
3	-0.0375	4.6
4	0.0206	4.8
5	0.0240	4
6	-0.0050	4.9
7	0.0240	4.9
8	0.0167	4.6
9	0.0167	4.6
10	0.0350	5.1
11	-0.0111	5.1
12	-0.0436	4
13	-0.0436	4
14	0.0240	4.9
15	-0.0443	4.3
16	0.0206	4.9
17	0.0206	4.8
18	0.0206	4.9
19	-0.0443	3.8
20	-0.0750	4.9
21	-0.0050	4.6
22	0.0240	4
23	0.0240	4
24	0.0240	5.1
25	0.0240	4.6
26	0.0240	5.7
27	-0.0163	4.9
28	-0.0163	5.5
29	0.0206	4.9
30	-0.0194	4.8
31	-0.0194	4
32	0.0240	4.1
33	0.0240	4.5
34	0.0240	4.5
35	0.0240	4
36	-0.0125	4.3
37	-0.0125	3.8
38	-0.0075	4
39	-0.0436	4.1
40	-0.1033	5.5
41	-0.0075	4.5
42	-0.0075	4
43	-0.0050	4.9
44	-0.0100	4.6
45	-0.0050	4.6
46	-0.0163	4

ID	Project No	Location (County)	Project Type	Letting Date	Number of Bids
47	35-1(85)	Love	Resurfacing	1/26/95	4
48	35-3(241)	Oklahoma	Overlay	2/23/95	2
49	35(211)	Johnson	Resurfacing	6/22/95	4
50	35(222)	Johnson	Resurfacing	4/25/96	3
51	36(303)	Kay	Resurfacing	4/20/95	4
52	36(319)	Kay	Resurfacing	4/25/96	0
53	37(172)	Kingfisher	Surfacing	7/25/96	6
54	37(171)	Kingfisher	Resurfacing	4/20/95	2
55	37(170)	Kingfisher	Resurfacing	4/20/95	5
56	37(177)	Kingfisher	Resurfacing	4/25/96	4
57	27(258)	Grant	Resurfacing	4/20/95	1
58	27(262)	Grant	Surfacing	4/3/95	0
59	27(265)	Grant	Surfacing	8/14/95	0
60	27(286)	Grant	Resurfacing	4/25/96	0
61	30N(023)	Rogers	Surfacing	1/23/97	3
62	32(167)	Hughes	Surfacing	1/26/95	4
63	32(215)	Hughes	Resurfacing	6/22/95	3
64	32(219)	Hughes	Surfacing	7/25/96	3
65	33B(156)	Jackson	Surfacing	1/26/95	2
66	33(165)	Jackson	Surfacing	2/23/95	2
67	19(305)	Creek	Resurfacing	6/22/95	3
68	20(240)	Custer	Surfacing	7/27/95	3
69	20(304)	Custer	Resurfacing	2/22/96	4
70	21C(254)	Delaware	Surfacing	3/23/95	2
71	21(280)	Delaware	Resurfacing	3/21/96	3
72	21(280)	Delaware	Resurfacing	3/21/96	3
73	21(276)	Delaware	Overlay	3/23/95	2
74	23(135)	Ellis	Resurfacing	7/25/96	1
75	24B(208)	Garfield	Surfacing	5/25/95	1
76	24(240)	Garfield	Resurfacing	4/20/95	1
77	24(257)	Garfield	Resurfacing	4/25/96	2
78	24(245)	Garfield	Resurfacing	3/21/96	1
79	24(241)	Garfield	Resurfacing	4/20/95	1
80	25(311)	Garvin	Resurfacing	4/20/95	5
81	25(312)	Garvin	Resurfacing	6/22/95	3
82	25(323)	Garvin	Resurfacing	4/25/96	7
83	26C(233)	Grady	Surfacing	4/20/95	3
84	26(295)	Grady	Overlay	1/25/96	4
85	26(294)	Grady	Overlay	1/25/96	0
86	26(288)	Grady	Resurfacing	4/20/95	5
87	10(346)	Carter	Surfacing	3/21/96	2
88	10(347)	Jefferson	Resurfacing	4/20/95	4
89	10(362)	Carter	Resurfacing	4/25/96	1
90	10(363)	Carter	Resurfacing	4/25/96	1
91	11C(337)	Cherokee	Surfacing	1/23/97	5
92	11(386)	Delaware	Overlay	3/23/95	7

ID	Lowest Bid	2nd Lowest Bid	Highest Bid	MLOT	Bid Range
47	$2,157,646.21	$2,233,859.04	$2,714,744.45	$76,212.83	$557,098.24
48	$575,394.50	$698,457.60	$698,457.60	$123,063.10	$123,063.10
49	$463,362.50	$477,536.70	$564,017.90	$14,174.20	$100,655.40
50	$220,110.12	$237,394.49	$245,369.75	$17,284.37	$25,259.63
51	$1,216,269.00	$1,243,847.50	$1,498,185.50	$27,578.50	$281,916.50
52	$0.00	$0.00	$0.00	$0.00	$0.00
53	$95,006.70	$98,278.00	$135,583.00	$3,271.30	$40,576.30
54	$91,463.65	$106,669.75	$106,669.75	$15,206.10	$15,206.10
55	$103,528.75	$120,273.75	$162,355.00	$16,745.00	$58,826.25
56	$314,780.00	$324,025.00	$343,485.50	$9,245.00	$28,705.50
57	$53,271.69	$53,271.69	$53,271.69	$0.00	$0.00
58	$0.00	$0.00	$0.00	$0.00	$0.00
59	$0.00	$0.00	$0.00	$0.00	$0.00
60	$0.00	$0.00	$0.00	$0.00	$0.00
61	$389,977.19	$534,835.66	$595,847.85	$144,858.47	$205,870.66
62	$888,210.40	$905,175.45	$1,132,975.20	$16,965.05	$244,764.80
63	$411,630.15	$440,377.55	$462,922.00	$28,747.40	$51,291.85
64	$246,096.72	$251,881.81	$284,102.65	$5,785.09	$38,005.93
65	$1,835,630.78	$1,849,131.96	$1,849,131.96	$13,501.18	$13,501.18
66	$196,828.35	$252,919.89	$252,919.89	$56,091.54	$56,091.54
67	$693,532.00	$728,128.00	$835,605.50	$34,596.00	$142,073.50
68	$896,891.10	$1,025,618.50	$1,044,942.25	$128,727.40	$148,051.15
69	$995,551.00	$997,934.95	$1,019,688.85	$2,383.95	$24,137.85
70	$843,926.21	$914,814.57	$914,814.57	$70,888.36	$70,888.36
71	$129,097.77	$146,858.20	$163,857.80	$17,760.43	$34,760.03
72	$298,567.84	$327,865.50	$358,947.00	$29,297.66	$60,379.16
73	$80,324.00	$84,545.00	$84,545.00	$4,221.00	$4,221.00
74	$418,066.95	$418,066.95	$418,066.95	$0.00	$0.00
75	$1,920,149.45	$1,920,149.45	$1,920,149.45	$0.00	$0.00
76	$187,315.00	$187,315.00	$187,315.00	$0.00	$0.00
77	$267,416.00	$316,133.25	$316,133.25	$48,717.25	$48,717.25
78	$726,491.10	$726,491.10	$726,491.10	$0.00	$0.00
79	$312,500.00	$312,500.00	$312,500.00	$0.00	$0.00
80	$203,020.40	$204,189.80	$267,509.30	$1,169.40	$64,488.90
81	$956,353.54	$1,202,022.38	$1,380,404.40	$245,668.84	$424,050.86
82	$514,677.97	$525,109.80	$796,724.28	$10,431.83	$282,046.31
83	$1,840,395.85	$1,945,571.66	$1,983,103.88	$105,175.81	$142,708.03
84	$407,454.60	$439,601.60	$513,571.20	$32,147.00	$106,116.60
85	$0.00	$0.00	$0.00	$0.00	$0.00
86	$495,026.00	$498,369.00	$681,742.00	$3,343.00	$186,716.00
87	$99,590.00	$102,790.00	$102,790.00	$3,200.00	$3,200.00
88	$1,259,946.00	$1,266,775.00	$1,669,178.00	$6,829.00	$409,232.00
89	$468,832.50	$468,832.50	$468,832.50	$0.00	$0.00
90	$198,589.00	$198,589.00	$198,589.00	$0.00	$0.00
91	$1,196,989.50	$1,334,275.75	$1,480,246.65	$137,286.25	$283,257.15
92	$324,440.00	$336,198.00	$363,428.00	$11,758.00	$38,988.00

ID	Engr's Estimate	Contract Amount	Contract Difference	Actual Cost	Cost Growth
47	$2,634,778.90	$2,157,646.21	($477,132.69)	$2,246,270.62	4.11%
48	$537,887.58	$575,394.50	$37,506.92	$528,335.73	-8.18%
49	$453,382.00	$463,362.50	$9,980.50	$461,121.16	-0.48%
50	$271,125.10	$220,110.12	($51,014.98)	$219,597.16	-0.23%
51	$1,250,973.75	$1,216,269.00	($34,704.75)	$1,182,892.36	-2.74%
52	$0.00	$641,414.50	$641,414.50	$620,163.77	-3.31%
53	$105,695.00	$95,006.70	($10,688.30)	$95,372.44	0.38%
54	$71,386.00	$91,463.65	$20,077.65	$86,234.40	-5.72%
55	$104,845.00	$103,528.75	($1,316.25)	$108,899.89	5.19%
56	$359,800.00	$314,780.00	($45,020.00)	$306,346.50	-2.68%
57	$50,658.25	$53,271.69	$2,613.44	$50,688.34	-4.85%
58	$0.00	$151,742.00	$151,742.00	$151,525.28	-0.14%
59	$0.00	$98,075.00	$98,075.00	$98,075.00	0.00%
60	$0.00	$365,640.00	$365,640.00	$366,283.12	0.18%
61	$268,308.75	$389,977.19	$121,668.44	$374,183.90	-4.05%
62	$811,719.55	$888,210.40	$76,490.85	$978,410.32	10.16%
63	$397,821.00	$411,630.15	$13,809.15	$410,002.11	-0.40%
64	$263,772.30	$246,096.72	($17,675.58)	$239,515.54	-2.67%
65	$1,556,192.66	$1,835,630.78	$279,438.12	$1,965,604.33	7.08%
66	$199,698.42	$196,828.35	($2,870.07)	$179,253.42	-8.93%
67	$652,030.00	$693,532.00	$41,502.00	$616,469.08	-11.11%
68	$837,860.00	$896,891.10	$59,031.10	$904,571.96	0.86%
69	$1,017,519.10	$995,551.00	($21,968.10)	$985,563.93	-1.00%
70	$876,044.39	$843,926.21	($32,118.18)	$721,914.92	-14.46%
71	$125,763.00	$129,097.77	$3,334.77	$127,940.40	-0.90%
72	$279,005.00	$298,567.84	$19,562.84	$299,144.56	0.19%
73	$84,395.00	$80,321.00	($4,074.00)	$75,834.11	-5.59%
74	$416,849.50	$418,066.95	$1,217.45	$413,959.76	-0.98%
75	$1,678,981.00	$1,920,149.45	$241,168.45	$1,942,503.29	1.16%
76	$175,100.00	$187,315.00	$12,215.00	$195,648.42	4.45%
77	$331,405.00	$267,416.00	($63,989.00)	$236,902.21	-11.41%
78	$717,694.40	$726,491.10	$8,796.70	$698,591.41	-3.84%
79	$293,926.00	$312,500.00	$18,574.00	$280,006.26	-10.40%
80	$197,778.00	$203,020.40	$5,242.40	$192,161.02	-5.35%
81	$892,788.40	$956,353.54	$63,565.14	$974,485.35	1.90%
82	$660,714.50	$514,677.97	($146,036.53)	$501,817.68	-2.50%
83	$1,815,922.68	$1,840,395.85	$24,473.17	$1,933,481.94	5.06%
84	$451,781.00	$407,454.60	($44,326.40)	$389,944.08	-4.30%
85	$0.00	$492,168.40	$492,168.40	$461,290.60	-6.27%
86	$486,376.00	$495,026.00	$8,650.00	$478,974.48	-3.24%
87	$106,000.00	$99,590.00	($6,410.00)	$99,586.08	0.00%
88	$1,123,482.50	$1,259,946.00	$136,463.50	$1,234,189.35	-2.04%
89	$547,816.25	$468,832.50	($78,983.75)	$460,989.23	-1.67%
90	$227,238.00	$198,589.00	($28,649.00)	$194,429.82	-2.09%
91	$1,204,445.20	$1,196,989.50	($7,455.70)	$1,221,004.36	2.01%
92	$420,700.00	$324,440.00	($96,260.00)	$322,388.45	-0.63%

ID	Duration	Contractor	Number of Projects
47	551	Interstate Contracting Corp.	2
48	366	T. J. Campbell Const. Co.	3
49	60	Northern Improvement Company	3
50	120	Shears Construction Co.	19
51	87	Shears Construction Co.	19
52	70	The Cummins Construction Co., Inc.	35
53	100	Mcconnell Construction, Inc.	3
54	60	Mcconnell Construction, Inc.	3
55	116	Shell Const. Co., Inc.	2
56	36	The Cummins Construction Co., Inc.	35
57	109	Evans & Associates Const.	4
58	118	Grant County Commissioners	1
59	20	The Cummins Construction Co., Inc.	35
60	42	The Cummins Construction Co., Inc.	35
61	162	Bemis Construction, Inc.	1
62	268	Glover Construction Co., Inc.	30
63	56	The Cummins Construction Co., Inc.	35
64	90	The Cummins Construction Co., Inc.	35
65	467	Shears Construction Co.	19
66	229	Shears Construction Co.	19
67	271	APAC-Oklahoma, Inc.	7
68	185	Comell Constr. Co., Inc.	8
69	184	Circle S Paving Co., Inc.	4
70	249	Barnhart Construction	1
71	296	The Cummins Construction Co., Inc.	35
72	296	The Cummins Construction Co., Inc.	35
73	98	Glover Construction Co., Inc.	30
74	100	Broce Const. Co., Inc.	18
75	599	The Cummins Construction Co., Inc.	35
76	80	The Cummins Construction Co., Inc.	35
77	21	The Cummins Construction Co., Inc.	35
78	234	Shears Construction Co.	19
79	91	The Cummins Construction Co., Inc.	35
80	45	Haskell Lemon Construction Co.	11
81	63	Broce Const. Co., Inc.	18
82	90	Shears Construction Co.	19
83	740	Bruton Construction Co., Inc.	1
84	93	Broce Const. Co., Inc.	18
85	86	Shears Construction Co.	19
86	129	Shears Construction Co.	19
87	227	Broce Const. Co., Inc.	18
88	399	Shears Construction Co.	19
89	304	Broce Const. Co., Inc.	18
90	131	Broce Const. Co., Inc.	18
91	197	Frix & Foster Const. Co., Inc.	1
92	62	Empire Construction & Materials, Inc.	6

ID	Total Cost Growth	Resident Engineer	Weather	No of Bad Weather Days
47	0.03	ac	Yes	120
48	-0.31	q	Yes	61
49	-0.05	t	No	0
50	-0.21	ap	Yes	20
51	-0.21	ah	Yes	36
52	-0.57	ah	No	0
53	0.01	l	No	0
54	0.01	ao	No	0
55	0.07	ao	No	0
56	-0.57	l	No	0
57	-0.15	ao	No	0
58	0	ab	Yes	61
59	-0.57	ao	No	0
60	-0.57	l	No	0
61	-0.04	am	Yes	61
62	0.72	l	Yes	42
63	-0.57	l	No	0
64	-0.57	l	No	0
65	-0.21	m	Yes	58
66	-0.21	m	Yes	61
67	-0.31	ae	Yes	17
68	0.22	aq	Yes	120
69	-0.05	aq	Yes	60
70	-0.14	am	Yes	45
71	-0.57	am	Yes	61
72	-0.57	am	Yes	61
73	0.72	am	No	0
74	-0.35	j	No	0
75	-0.57	l	Yes	66
76	-0.57	ao	No	0
77	-0.57	l	No	0
78	-0.21	l	Yes	58
79	-0.57	ao	No	0
80	-0.48	t	Yes	37
81	-0.35	p	Yes	61
82	-0.21	p	No	0
83	0.05	g	Yes	128
84	-0.35	w	Yes	61
85	-0.21	g	Yes	40
86	-0.21	g	Yes	38
87	-0.35	ad	Yes	61
88	-0.21	w	Yes	96
89	-0.35	ad	No	0
90	-0.35	ad	No	0
91	0.02	aj	Yes	61
92	-0.21	c	Yes	61

ID	Bad weather Days Ratio	Bidding Environment	Plans Review Time	Unit System
47	0.21785		21	English
48	0.16679		21	English
49	0.000021		21	English
50	0.166716		21	English-Metric
51	0.413827		21	English
52	0.000016		21	English-Metric
53	0.000011		21	English-Metric
54	0.000027		21	English
55	0.000027		21	English
56	0.000016		21	English-Metric
57	0.000027		21	English
58	0.516927		21	English
59	0.00006		21	English
60	0.000016		21	English-Metric
61	0.37655		21	English-Metric
62	0.15675		21	English
63	0.000021		21	English
64	0.000011		21	English-Metric
65	0.12425		21	English
66	0.26649		21	English
67	0.062721		21	English
68	0.64864		21	English
69	0.32613		21	English-Metric
70	0.180720		21	English
71	0.206111		21	English-Metric
72	0.206111		21	English-Metric
73	0.000020		21	English
74	0.000011		21	English-Metric
75	0.110212		21	English
76	0.000027		21	English
77	0.000016		21	English-Metric
78	0.247911		21	English-Metric
79	0.000027		21	English
80	0.822227		21	English
81	0.968321		21	English
82	0.000016		21	English-Metric
83	0.173027		21	English
84	0.65596		21	English-Metric
85	0.46516		21	English-Metric
86	0.294627		21	English
87	0.268711		21	English-Metric
88	0.240627		21	English
89	0.000016		21	English-Metric
90	0.000016		21	English-Metric
91	0.30965		21	English-Metric
92	0.983920		21	English

ID	Out-of-State Firms	Work Order Date	Timing of Work Order	Contractors History
47	Yes	3/6/95	39	Yes
48	No	3/27/95	32	No
49	Yes	8/31/95	70	No
50	Yes	6/10/96	46	Yes
51	Yes	5/24/95	34	Yes
52	No	6/6/96	42	Yes
53	No	8/22/96	28	Yes
54	No	5/23/95	33	Yes
55	No	5/22/95	32	Yes
56	Yes	6/6/96	42	Yes
57	No	6/15/95	56	No
58	No	4/4/95	1	No
59	No	8/17/95	3	Yes
60	No	6/6/96	42	Yes
61	Yes	2/19/97	27	No
62	Yes	3/6/95	39	Yes
63	No	8/2/95	41	Yes
64	No	8/28/96	34	Yes
65	No	3/13/95	46	Yes
66	No	3/29/95	34	Yes
67	No	8/7/95	46	Yes
68	No	8/28/95	32	Yes
69	No	3/29/96	36	Yes
70	No	5/15/95	53	No
71	No	4/23/96	33	Yes
72	No	4/23/96	33	Yes
73	Yes	4/21/95	29	Yes
74	No	8/28/96	34	Yes
75	No	8/23/95	90	Yes
76	No	5/24/95	34	Yes
77	No	6/6/96	42	Yes
78	No	5/2/96	42	Yes
79	No	5/26/95	36	Yes
80	No	5/23/95	33	Yes
81	No	7/27/95	35	Yes
82	Yes	5/23/96	28	Yes
83	No	6/2/95	43	Yes
84	No	3/1/96	36	Yes
85	No	3/1/96	36	Yes
86	No	5/22/95	32	Yes
87	No	4/22/96	32	Yes
88	Yes	5/24/95	34	Yes
89	No	5/29/96	34	Yes
90	No	5/24/96	29	Yes
91	No	4/14/97	81	Yes
92	Yes	5/1/95	39	No

ID	Projects with Overrun	Average No of Projects with O/R	Average Overrun
47	1	0.5000	4.1100
48	0	0.0000	0.0000
49	0	0.0000	0.0000
50	3	0.1579	7.2733
51	3	0.1579	7.2733
52	10	0.2857	2.8000
53	2	0.6667	3.5150
54	2	0.6667	3.5150
55	2	1.0000	3.2700
56	10	0.2857	2.8000
57	0	0.0000	0.0000
58	0	0.0000	0.0000
59	10	0.2857	2.8000
60	10	0.2857	2.8000
61	0	0.0000	0.0000
62	11	0.3667	14.2400
63	10	0.2857	2.8000
64	10	0.2857	2.8000
65	3	0.1579	7.2733
66	3	0.1579	7.2733
67	1	0.1429	1.2200
68	4	0.5000	7.1575
69	1	0.2500	0.0200
70	0	0.0000	0.0000
71	10	0.2857	2.8000
72	10	0.2857	2.8000
73	11	0.3667	14.2400
74	1	0.0556	1.9000
75	10	0.2857	2.8000
76	10	0.2857	2.8000
77	10	0.2857	2.8000
78	3	0.1579	7.2733
79	10	0.2857	2.8000
80	2	0.1818	2.6800
81	1	0.0556	1.9000
82	3	0.1579	7.2733
83	1	1.0000	5.0600
84	1	0.0556	1.9000
85	3	0.1579	7.2733
86	3	0.1579	7.2733
87	1	0.0556	1.9000
88	3	0.1579	7.2733
89	1	0.0556	1.9000
90	1	0.0556	1.9000
91	1	1.0000	2.0100
92	0	0.0000	0.0000

ID	Average Cost Growth	Availability of Labor
47	0.0150	5.7
48	-0.1033	5.5
49	-0.0167	4.8
50	-0.0111	4
51	-0.0111	4.6
52	-0.0163	4
53	0.0033	3.8
54	0.0033	4.6
55	0.0350	4.6
56	-0.0163	4
57	-0.0375	4.6
58	0.0000	4.6
59	-0.0163	4.3
60	-0.0163	4
61	-0.0400	4.8
62	0.0240	5.7
63	-0.0163	4.8
64	-0.0163	3.8
65	-0.0111	5.7
66	-0.0111	5.5
67	-0.0443	4.8
68	0.0275	4.6
69	-0.0125	5
70	-0.1400	4.9
71	-0.0163	4.1
72	-0.0163	4.1
73	0.0240	4.9
74	-0.0194	3.8
75	-0.0163	4.9
76	-0.0163	4.6
77	-0.0163	4
78	-0.0111	4.1
79	-0.0163	4.6
80	-0.0436	4.6
81	-0.0194	4.8
82	-0.0111	4
83	0.0500	4.6
84	-0.0194	5.1
85	-0.0111	5.1
86	-0.0111	4.6
87	-0.0194	4.1
88	-0.0111	4.6
89	-0.0194	4
90	-0.0194	4
91	0.0200	4.8
92	-0.0350	4.9

ID	Project No	Location (County)	Project Type	Letting Date	Number of Bids
93	11(376)	Cherokee	Overlay	2/23/95	7
94	12(211)	Choctaw	Resurfacing	6/22/95	2
95	13(131)	Cimarron	Overlay	1/26/95	2
96	13(136)	Cimarron	Overlay	3/23/95	2
97	13(138)	Cimarron	Resurfacing	6/22/95	1
98	14(256)	Cleveland	Surfacing	2/23/95	7
99	14(393)	Cleveland	Resurfacing	4/20/95	9
100	14(423)	Cleveland	Resurfacing	7/25/96	4
101	15(149)	Coal	Resurfacing	4/20/95	3
102	16(312)	Comanche	Resurfacing	5/25/95	2
103	16(309)	Comanche	Resurfacing	8/24/95	1
104	16(315)	Comanche	Overlay	3/23/95	2
105	18(148)	Craig	Resurfacing	3/21/96	1
106	18(148)	Craig	Resurfacing	3/21/96	1
107	18(145)	Craig	Resurfacing	4/20/95	4
108	18(144)	Craig	Resurfacing	11/16/95	1
109	18(142)	Craig	Resurfacing	7/27/95	2
110	1(168)	Adair	Resurfacing	2/22/96	3
111	1(164)	Adair	Resurfacing	4/20/95	5
112	2C(182)	Alfalfa	Resurfacing	6/22/95	1
113	2(225)	Alfalfa	Resurfacing	5/23/96	2
114	3(250)	Atoka	Resurfacing	6/22/95	2
115	4C(146)	Beaver	Surfacing	6/22/95	3
116	4(173)	Beaver	Resurfacing	6/22/95	2
117	5(194)	Beckham	Resurfacing	6/22/95	1
118	5(223)	Washita	Resurfacing	6/22/95	3
119	5(222)	Beckham	Resurfacing	6/22/95	3
120	6(197)	Dewey	Overlay	2/23/95	3
121	7(229)	Bryan	Surfacing	3/23/95	2
122	7(325)	Bryan	Resurfacing	3/23/95	1
123	7(332)	Bryan	Resurfacing	6/22/95	3
124	7(342)	Bryan	Resurfacing	6/20/96	5
125	8(366)	Caddo	Resurfacing	1/25/96	0
126	9(239)	Canadian	Surfacing	4/25/96	5
127	67(246)	Seminole	Surfacing	5/23/96	3
128	67(226)	Seminole	Resurfacing	4/20/95	2
129	67(227)	Seminole	Resurfacing	4/20/95	2
130	67(224)	Seminole	Overlay	3/23/95	3
131	64(263)	Pushmataha	Resurfacing	6/20/96	2
132	62(274)	Pontotoc	Resurfacing	6/22/95	4
133	61(416)	Pittsburg	Resurfacing	6/20/96	3
134	61(409)	Pittsburg	Resurfacing	10/26/95	3
135	60(308)	Payne	Resurfacing	4/25/96	3
136	60(302)	Payne	Resurfacing	6/22/95	1
137	60(301)	Payne	Resurfacing	3/21/96	3
138	60(299)	Payne	Resurfacing	4/20/95	1

ID	Lowest Bid	2nd Lowest Bid	Highest Bid	MLOT	Bid Range
93	$322,796.22	$326,205.20	$373,993.74	$3,408.98	$51,197.52
94	$675,361.50	$830,429.50	$830,429.50	$155,068.00	$155,068.00
95	$523,588.00	$650,728.00	$650,728.00	$127,140.00	$127,140.00
96	$648,893.02	$745,616.10	$745,616.10	$96,723.08	$96,723.08
97	$396,257.16	$396,257.16	$396,257.16	$0.00	$0.00
98	$288,691.58	$289,577.05	$370,363.42	$885.47	$81,671.84
99	$238,088.20	$259,194.00	$353,615.70	$21,105.80	$115,527.50
100	$538,515.30	$570,842.00	$613,340.25	$32,326.70	$74,824.95
101	$491,871.80	$521,967.10	$581,108.20	$30,095.30	$89,236.40
102	$18,805.00	$20,548.10	$20,548.10	$1,743.10	$1,743.10
103	$79,682.50	$79,682.50	$79,682.50	$0.00	$0.00
104	$773,653.73	$818,863.00	$818,863.00	$45,209.27	$45,209.27
105	$42,135.50	$42,135.50	$42,135.50	$0.00	$0.00
106	$304,466.50	$304,466.50	$304,466.50	$0.00	$0.00
107	$362,313.80	$404,699.20	$0.00	$42,385.40	($362,313.80)
108	$34,811.50	$34,811.50	$34,811.50	$0.00	$0.00
109	$465,177.88	$527,000.20	$527,000.20	$61,822.32	$61,822.32
110	$85,468.50	$90,642.00	$97,666.50	$5,173.50	$12,198.00
111	$1,027,032.50	$1,058,237.50	$1,165,654.00	$31,205.00	$138,621.50
112	$490,372.80	$490,372.80	$490,372.80	$0.00	$0.00
113	$330,415.45	$347,659.90	$347,659.90	$17,244.45	$17,244.45
114	$204,245.00	$206,569.50	$206,569.50	$2,324.50	$2,324.50
115	$2,397,807.06	$2,441,176.69	$2,685,376.13	$43,369.63	$287,569.07
116	$605,787.04	$625,027.36	$625,027.36	$19,240.32	$19,240.32
117	$448,402.00	$448,402.00	$448,402.00	$0.00	$0.00
118	$1,073,466.10	$1,162,708.91	$1,173,794.30	$89,242.81	$100,328.20
119	$485,207.00	$531,702.63	$543,917.57	$46,495.63	$58,710.57
120	$1,463,736.92	$1,616,960.56	$1,661,216.22	$153,223.64	$197,479.30
121	$686,789.74	$769,787.47	$769,787.47	$82,997.73	$82,997.73
122	$141,424.37	$141,424.37	$141,424.37	$0.00	$0.00
123	$168,490.50	$211,316.56	$211,380.60	$42,826.06	$42,890.10
124	$719,882.40	$762,803.00	$960,286.20	$42,920.60	$240,403.80
125	$0.00	$0.00	$0.00	$0.00	$0.00
126	$821,583.63	$846,049.85	$1,185,765.75	$24,466.22	$364,182.12
127	$61,687.00	$69,656.50	$92,143.00	$7,969.50	$30,456.00
128	$38,815.10	$39,080.40	$39,080.40	$265.30	$265.30
129	$48,514.35	$49,275.85	$49,275.85	$761.50	$761.50
130	$49,653.20	$53,813.30	$56,523.47	$4,160.10	$6,870.27
131	$195,650.00	$223,594.00	$223,594.00	$27,944.00	$27,944.00
132	$442,922.85	$449,342.05	$598,046.72	$6,419.20	$155,123.87
133	$409,725.06	$410,408.35	$448,629.20	$683.29	$38,904.14
134	$435,327.70	$444,744.01	$464,647.14	$9,416.31	$29,319.44
135	$827,312.95	$845,237.47	$874,410.45	$17,924.52	$47,097.50
136	$278,742.50	$278,742.50	$278,742.50	$0.00	$0.00
137	$368,405.32	$405,296.63	$464,377.20	$36,891.31	$95,971.88
138	$221,516.25	$221,516.25	$221,516.25	$0.00	$0.00

ID	Engr's Estimate	Contract Amount	Contract Difference	Actual Cost	Cost Growth
93	$412,282.80	$322,796.22	($89,486.58)	$339,490.45	5.17%
94	$692,509.50	$675,361.50	($17,148.00)	$660,758.70	-2.16%
95	$786,640.00	$523,588.00	($263,052.00)	$520,117.51	-0.66%
96	$687,756.00	$648,893.02	($38,862.98)	$646,121.17	-0.43%
97	$353,776.00	$396,257.16	$42,481.16	$395,219.28	-0.26%
98	$306,819.69	$288,691.58	($18,128.11)	$279,496.47	-3.19%
99	$240,081.00	$238,088.20	($1,992.80)	$238,591.68	0.21%
100	$558,982.50	$538,515.30	($20,467.20)	$595,581.51	10.60%
101	$483,422.00	$491,871.80	$8,449.80	$488,368.44	-0.71%
102	$15,760.00	$18,805.00	$3,045.00	$17,382.54	-7.56%
103	$0.00	$79,682.50	$79,682.50	$71,268.48	-10.56%
104	$683,905.00	$773,653.73	$89,748.73	$742,615.76	-4.01%
105	$43,340.00	$42,135.50	($1,204.50)	$39,378.96	-6.54%
106	$272,640.00	$304,466.50	$31,826.50	$297,529.23	-2.28%
107	$389,495.00	$362,313.80	($27,181.20)	$347,727.04	-4.03%
108	$31,813.00	$34,811.50	$2,998.50	$31,490.72	-9.54%
109	$411,413.40	$465,177.88	$53,764.48	$463,206.92	-0.42%
110	$93,730.00	$85,468.50	($8,261.50)	$85,402.00	-0.08%
111	$1,025,360.00	$1,027,032.50	$1,672.50	$1,029,901.55	0.28%
112	$424,440.80	$490,372.80	$65,932.00	$461,575.91	-5.87%
113	$303,410.04	$330,415.45	$27,005.41	$320,563.34	-2.98%
114	$190,655.50	$204,245.00	$13,589.50	$206,448.98	1.08%
115	$2,448,609.20	$2,397,807.06	($50,802.14)	$2,442,376.93	1.86%
116	$567,308.00	$605,787.04	$38,479.04	$605,806.17	0.00%
117	$410,226.00	$448,402.00	$38,176.00	$431,310.44	-3.81%
118	$1,159,483.00	$1,073,466.10	($86,016.90)	$1,073,149.63	-0.03%
119	$492,605.00	$485,207.00	($7,398.00)	$473,628.15	-2.39%
120	$1,333,009.73	$1,463,736.92	$130,727.19	$1,463,736.92	0.00%
121	$551,023.54	$686,789.74	$135,766.20	$686,760.29	0.00%
122	$107,838.20	$141,424.37	$33,586.17	$138,300.11	-2.21%
123	$166,981.40	$168,490.50	$1,509.10	$168,248.76	-0.14%
124	$882,274.50	$719,882.40	($162,392.10)	$714,130.08	-0.80%
125	$0.00	$379,880.51	$379,880.51	$363,253.63	-4.38%
126	$891,363.00	$821,583.63	($69,779.37)	$842,972.72	2.60%
127	$61,101.25	$61,687.00	$585.75	$65,614.92	6.37%
128	$34,452.25	$38,815.10	$4,362.85	$38,764.44	-0.13%
129	$46,790.00	$48,514.35	$1,724.35	$48,295.82	-0.45%
130	$52,615.20	$49,653.20	($2,962.00)	$46,310.39	-6.73%
131	$203,280.00	$195,650.00	($7,630.00)	$192,396.55	-1.66%
132	$430,776.40	$442,922.85	$12,146.45	$421,176.19	-4.91%
133	$419,305.00	$409,725.06	($9,579.94)	$402,853.89	-1.68%
134	$424,784.07	$435,327.70	$10,543.63	$428,013.98	-1.68%
135	$876,080.80	$827,312.95	($48,767.85)	$923,174.50	11.59%
136	$248,640.00	$278,742.50	$30,102.50	$275,226.19	-1.26%
137	$396,823.80	$368,405.32	($28,418.48)	$365,313.26	-0.84%
138	$192,113.00	$221,516.25	$29,403.25	$236,549.69	6.79%

ID	Duration	Contractor	Number of Projects
93	158	S. G. & S. Construction, Inc.	2
94	194	The Cummins Construction Co., Inc.	35
95	60	J. & R. Sand Company, Inc.	3
96	45	Highway Contractors, Inc.	8
97	60	Highway Contractors, Inc.	8
98	130	Silver Star Truck Lines, Inc.	2
99	60	Edmond Paving & Const. Co.	3
100	94	Shears Construction Co.	19
101	60	AMIS/OTAC	4
102	38	T & G Construction Co., Inc.	6
103	53	T & G Construction Co., Inc.	6
104	188	Shears Construction Co.	19
105	266	Tri-State Asphalt, Inc.	3
106	266	Tri-State Asphalt, Inc.	3
107	179	Vinita Rock Company	7
108	59	Glover Construction Co., Inc.	30
109	93	Bellco Materials, Inc.	16
110	75	Glover Construction Co., Inc.	30
111	375	Glover Construction Co., Inc.	30
112	62	The Cummins Construction Co., Inc.	35
113	100	Broce Const. Co., Inc.	18
114	134	The Cummins Construction Co., Inc.	35
115	428	J. & R. Sand Company, Inc.	3
116	90	Highway Contractors, Inc.	8
117	75	Broce Const. Co., Inc.	18
118	90	Comell Constr. Co., Inc.	8
119	90	Comell Constr. Co., Inc.	8
120	100	Comell Constr. Co., Inc.	8
121	363	M. L. Young Construction Corporation	1
122	99	Vantage Paving, Inc.	1
123	168	The Cummins Construction Co., Inc.	35
124	234	The Cummins Construction Co., Inc.	35
125	97	T & G Construction Co., Inc.	6
126	170	Sewell Brothers, Inc.	1
127	30	The Cummins Construction Co., Inc.	35
128	45	Shawnee Asphalt Company	6
129	45	Shawnee Asphalt Company	6
130	30	The Cummins Construction Co., Inc.	35
131	96	The Cummins Construction Co., Inc.	35
132	56	Broce Const. Co., Inc.	18
133	176	Job Construction Co., Inc.	12
134	239	AMIS/OTAC	4
135	188	The Quapaw Company	10
136	42	The Quapaw Company	10
137	84	The Quapaw Company	10
138	30	The Quapaw Company	10

ID	Total Cost Growth	Resident Engineer	Weather	No of Bad Weather Days
93	0.04b		Yes	61
94	-0.57t		No	0
95	0ai		No	0
96	-0.01ai		Yes	58
97	-0.01ai		No	0
98	-0.15p		No	0
99	0.05p		Yes	34
100	-0.21p		No	0
101	-0.05t		No	0
102	-0.2w		No	0
103	-0.2g		No	0
104	-0.21g		Yes	61
105	-0.1am		No	0
106	-0.1am		No	0
107	-0.28am		Yes	15
108	0.72am		No	0
109	0.33am		No	0
110	0.72c		Yes	36
111	0.72c		Yes	79
112	-0.57r		No	0
113	-0.35j		No	0
114	-0.57y		No	0
115	0ai		Yes	120
116	-0.01ai		No	0
117	-0.35aq		No	0
118	0.22aq		Yes	61
119	0.22aq		Yes	61
120	0.22aq		No	0
121	0ag		No	0
122	-0.02ag		Yes	34
123	-0.57ag		No	0
124	-0.57ag		No	0
125	-0.2g		No	0
126	0.03an		Yes	96
127	-0.57ap		No	0
128	-0.03l		No	0
129	-0.03l		No	0
130	-0.57t		No	0
131	-0.57d		No	0
132	-0.35t		No	0
133	-0.09y		No	0
134	-0.05y		Yes	61
135	-0.13z		Yes	38
136	-0.13z		No	0
137	-0.13z		Yes	21
138	-0.13z		No	0

ID	Bad weather Days Ratio	Bidding Environment	Plans Review Time	Unit System
93	0.38619		21	English
94	0.000021		21	English
95	0.00005		21	English
96	1.288920		21	English
97	0.000021		21	English
98	0.00009		21	English
99	0.566727		21	English
100	0.000011		21	English-Metric
101	0.000027		21	English
102	0.000012		21	English
103	0.00006		21	English
104	0.324520		21	English
105	0.000011		21	English-Metric
106	0.000011		21	English-Metric
107	0.083827		21	English
108	0.00002		21	English
109	0.00004		21	English
110	0.48003		21	English-Metric
111	0.210727		21	English
112	0.000021		21	English
113	0.00002		21	English-Metric
114	0.000021		21	English
115	0.280421		21	English
116	0.000021		21	English
117	0.000021		21	English
118	0.677821		21	English
119	0.677821		21	English
120	0.00009		21	English
121	0.000020		21	English
122	0.343420		21	English
123	0.000021		21	English
124	0.000026		21	English-Metric
125	0.00006		21	English-Metric
126	0.564716		21	English-Metric
127	0.00002		21	English-Metric
128	0.000027		21	English
129	0.000027		21	English
130	0.000020		21	English
131	0.000026		21	English-Metric
132	0.000021		21	English
133	0.000026		21	English-Metric
134	0.25523		21	English
135	0.202116		21	English-Metric
136	0.000021		21	English
137	0.250011		21	English-Metric
138	0.000027		21	English

ID	Out-of-State Firms	Work Order Date	Timing of Work Order	Contractors History
93	Yes	4/13/95	49	Yes
94	No	8/7/95	46	Yes
95	Yes	3/15/95	48	Yes
96	Yes	4/19/95	27	Yes
97	No	7/18/95	26	Yes
98	No	6/15/95	112	No
99	No	5/26/95	36	Yes
100	No	8/22/96	28	Yes
101	No	5/23/95	33	No
102	No	7/14/95	50	Yes
103	No	10/3/95	40	Yes
104	No	4/17/95	25	Yes
105	No	4/26/96	36	No
106	No	4/26/96	36	No
107	No	6/15/95	56	No
108	No	1/18/96	63	Yes
109	No	9/5/95	40	Yes
110	No	3/25/96	32	Yes
111	Yes	5/23/95	33	Yes
112	No	8/7/95	46	Yes
113	No	7/11/96	49	Yes
114	No	7/27/95	35	Yes
115	Yes	8/7/95	46	Yes
116	No	8/22/95	61	Yes
117	No	7/21/95	29	Yes
118	No	7/27/95	35	Yes
119	No	7/27/95	35	Yes
120	No	3/20/95	25	Yes
121	No	6/20/95	89	No
122	No	5/26/95	64	No
123	No	8/2/95	41	Yes
124	Yes	7/23/96	33	Yes
125	No	3/4/96	39	Yes
126	No	5/24/96	29	Yes
127	No	7/8/96	46	Yes
128	No	6/20/95	61	Yes
129	No	6/20/95	61	Yes
130	No	6/15/95	84	Yes
131	No	7/23/96	33	Yes
132	No	8/2/95	41	Yes
133	No	7/25/96	35	No
134	No	12/1/95	36	No
135	No	5/22/96	27	Yes
136	No	8/4/95	43	Yes
137	No	5/2/96	42	Yes
138	No	5/26/95	36	Yes

ID	Projects with Overrun	Average No of Projects with O/R	Average Overrun
93	1	0.5000	5.1700
94	10	0.2857	2.8000
95	1	0.3333	1.8600
96	1	0.1250	0.0000
97	1	0.1250	0.0000
98	0	0.0000	0.0000
99	2	0.6667	2.3100
100	3	0.1579	7.2733
101	0	0.0000	0.0000
102	1	0.1667	12.1100
103	1	0.1667	12.1100
104	3	0.1579	7.2733
105	0	0.0000	0.0000
106	0	0.0000	0.0000
107	0	0.0000	0.0000
108	11	0.3667	14.2400
109	5	0.3125	9.2540
110	11	0.3667	14.2400
111	11	0.3667	14.2400
112	10	0.2857	2.8000
113	1	0.0556	1.9000
114	10	0.2857	2.8000
115	1	0.3333	1.8600
116	1	0.1250	0.0000
117	1	0.0556	1.9000
118	4	0.5000	7.1575
119	4	0.5000	7.1575
120	4	0.5000	7.1575
121	0	0.0000	0.0000
122	0	0.0000	0.0000
123	10	0.2857	2.8000
124	10	0.2857	2.8000
125	1	0.1667	12.1100
126	1	1.0000	2.6000
127	10	0.2857	2.8000
128	1	0.1667	0.7100
129	1	0.1667	0.7100
130	10	0.2857	2.8000
131	10	0.2857	2.8000
132	1	0.0556	1.9000
133	0	0.0000	0.0000
134	0	0.0000	0.0000
135	3	0.3000	12.5000
136	3	0.3000	12.5000
137	3	0.3000	12.5000
138	3	0.3000	12.5000

ID	Average Cost Growth	Availability of Labor
93	0.0200	5.5
94	-0.0163	4.8
95	0.0000	5.7
96	-0.0012	4.9
97	-0.0012	4.8
98	-0.0750	5.5
99	0.0167	4.6
100	-0.0111	3.8
101	-0.0125	4.6
102	-0.0333	4.9
103	-0.0333	4.3
104	-0.0111	4.9
105	-0.0333	4.1
106	-0.0333	4.1
107	-0.0400	4.6
108	0.0240	4.1
109	0.0206	4.6
110	0.0240	5
111	0.0240	4.6
112	-0.0163	4.8
113	-0.0194	4.2
114	-0.0163	4.8
115	0.0000	4.8
116	-0.0012	4.8
117	-0.0194	4.8
118	0.0275	4.8
119	0.0275	4.8
120	0.0275	5.5
121	0.0000	4.9
122	-0.0200	4.9
123	-0.0163	4.8
124	-0.0163	4
125	-0.0333	5.1
126	0.0300	4
127	-0.0163	4.2
128	-0.0050	4.6
129	-0.0050	4.6
130	-0.0163	4.9
131	-0.0163	4
132	-0.0194	4.8
133	-0.0075	4
134	-0.0125	4.5
135	-0.0130	4
136	-0.0130	4.8
137	-0.0130	4.1
138	-0.0130	4.6

ID	Project No	Location (County)	Project Type	Letting Date	Number of Bids
139	60(297)	Payne	Overlay	3/23/95	1
140	59(183)	Pawnee	Resurfacing	3/21/96	3
141	58(283)	Ottawa	Resurfacing	4/24/97	2
142	58(279)	Ottawa	Overlay	3/23/95	2
143	58(278)	Ottawa	Resurfacing	3/23/95	2
144	76D(110)	Woods	Surfacing	7/27/95	6
145	75(198)	Washita	Resurfacing	7/25/96	4
146	74(167)	Washington	Resurfacing	3/21/96	2
147	73(370)	Wagoner	Resurfacing	8/24/95	3
148	73(358)	wagoner	Overlay	2/23/95	6
149	72(566)	Tulsa	Resurfacing	5/25/95	4
150	72E(503)	Tulsa	Surfacing	4/20/95	3
151	71(153)	Tillman	Overlay	2/23/95	3
152	70(210)	Texas	Resurfacing	6/22/95	2
153	70(207)	Texas	Resurfacing	5/25/95	2
154	69(269)	Stephens	Resurfacing	8/24/95	4
155	69(267)	Stephens	Resurfacing	4/20/95	2
156	69(217)	Stephens	Overlay	3/23/95	6
157	68(294)	Sequoyah	Resurfacing	9/25/97	2
158	68(275)	Sequoyah	Resurfacing	5/25/95	5
159	68(272)	Sequoyah	Resurfacing	3/23/95	4
160	68(227)	Sequoyah	Resurfacing	11/16/95	4
161	177C(003)	Woodward	Resurfacing	4/24/97	2
162	177A(001)	Woodward	Resurfacing	6/20/96	2
163	176C(008)	Woods	Resurfacing	5/22/97	3
164	176C(004)	Woods	Resurfacing	9/25/97	2
165	176D(003)	Woods	Resurfacing	7/24/97	1
166	176C(001)	Woods	Resurfacing	4/24/97	1
167	175D(002)	Washita	Resurfacing	7/25/96	3
168	174N(001)	Washington	Resurfacing	2/20/97	2
169	173N(012)	Wagoner	Surfacing	8/22/96	5
170	173A(004)	Wagoner	Resurfacing	6/20/96	5
171	172N(022)	Tulsa	Resurfacing	7/24/97	2
172	172N(007)	Tulsa	Resurfacing	7/25/96	2
173	171D(010)	Tillman	Resurfacing	2/20/97	4
174	171D(006)	Tillman	Resurfacing	7/25/96	3
175	171C(003)	Tillman	Resurfacing	6/20/96	4
176	170C(008)	Texas	Resurfacing	10/23/97	2
177	170C(001)	Texas	Resurfacing	6/20/96	1
178	168A(018)	Sequoyah	Resurfacing	7/24/97	4
179	168C(4,12)	Sequoyah	Resurfacing	7/24/97	3
180	167C(0020	Seminole	Resurfacing	3/27/97	4
181	166C(008)	Rogers	Resurfacing	6/26/97	4
182	166C(003)	Rogers	Resurfacing	6/20/96	3
183	163C(006)	Pottawatomie	Resurfacing	3/27/97	3
184	162B(001)	Pontotoc	Resurfacing	6/20/96	3

ID	Lowest Bid	2nd Lowest Bid	Highest Bid	MLOT	Bid Range
139	$153,340.00	$153,340.00	$153,340.00	$0.00	$0.00
140	$269,925.00	$293,784.00	$317,322.00	$23,859.00	$47,397.00
141	$349,914.80	$397,790.95	$397,790.95	$47,876.15	$47,876.15
142	$401,876.80	$469,882.50	$469,882.50	$68,005.70	$68,005.70
143	$196,261.00	$234,710.50	$234,710.50	$38,449.50	$38,449.50
144	$332,323.00	$348,851.00	$397,742.65	$16,528.00	$65,419.65
145	$500,682.25	$552,466.50	$564,773.75	$51,784.25	$64,091.50
146	$217,660.00	$245,038.90	$245,038.90	$27,378.90	$27,378.90
147	$315,197.00	$355,418.00	$439,029.50	$40,221.00	$123,832.50
148	$220,814.00	$237,107.50	$279,765.50	$16,293.50	$58,951.50
149	$1,030,439.70	$1,079,614.50	$1,486,939.50	$49,174.80	$456,499.80
150	$565,601.36	$609,807.80	$814,227.26	$44,206.44	$248,625.90
151	$252,324.00	$293,510.52	$297,466.72	$41,186.52	$45,142.72
152	$937,448.50	$963,597.30	$963,597.30	$26,148.80	$26,148.80
153	$596,116.40	$628,478.02	$628,478.02	$32,361.62	$32,361.62
154	$482,200.00	$511,407.00	$643,285.00	$29,207.00	$161,085.00
155	$217,969.70	$371,990.50	$371,990.50	$154,020.80	$154,020.80
156	$393,896.92	$397,030.65	$509,785.68	$3,133.73	$115,888.76
157	$39,683.58	$55,800.50	$55,800.50	$16,116.92	$16,116.92
158	$84,762.32	$88,304.85	$109,739.00	$3,542.53	$24,976.68
159	$76,788.16	$82,332.00	$94,587.68	$5,543.84	$17,799.52
160	$134,946.80	$136,799.06	$151,792.93	$1,852.26	$16,846.13
161	$392,365.40	$406,706.88	$406,706.88	$14,341.48	$14,341.48
162	$599,976.91	$619,704.33	$619,704.33	$19,727.42	$19,727.42
163	$558,509.80	$595,556.00	$645,287.50	$37,046.20	$86,777.70
164	$179,871.85	$187,159.05	$187,159.05	$7,287.20	$7,287.20
165	$152,840.50	$152,840.50	$152,840.50	$0.00	$0.00
166	$60,843.03	$60,843.03	$60,843.03	$0.00	$0.00
167	$66,045.00	$84,150.00	$88,995.00	$18,105.00	$22,950.00
168	$352,866.87	$452,368.23	$452,368.23	$99,501.36	$99,501.36
169	$307,383.75	$325,144.00	$447,702.80	$17,760.25	$140,319.05
170	$560,836.00	$563,200.00	$678,127.70	$2,364.00	$117,291.70
171	$2,132,314.53	$2,526,163.27	$2,526,163.27	$393,848.74	$393,848.74
172	$135,310.00	$136,414.00	$136,414.00	$1,104.00	$1,104.00
173	$198,224.70	$203,292.00	$242,734.50	$5,067.30	$44,509.80
174	$53,077.90	$64,715.50	$65,181.75	$11,637.60	$12,103.85
175	$391,063.33	$431,065.08	$501,772.44	$40,001.75	$110,709.11
176	$536,307.80	$614,613.50	$614,613.50	$78,305.70	$78,305.70
177	$538,649.00	$538,649.00	$538,649.00	$0.00	$0.00
178	$208,650.00	$223,672.50	$257,360.00	$15,022.50	$48,710.00
179	$293,000.00	$323,059.12	$366,047.20	$30,059.12	$73,047.20
180	$781,886.46	$821,927.64	$967,355.68	$40,041.18	$185,469.22
181	$490,537.20	$609,849.83	$725,647.10	$119,312.63	$235,109.90
182	$599,439.40	$633,939.30	$664,980.20	$34,499.90	$65,540.80
183	$539,600.84	$563,915.61	$667,828.00	$24,314.77	$128,227.16
184	$490,967.20	$517,468.30	$528,836.47	$26,501.10	$37,869.27

ID	Engr's Estimate	Contract Amount	Contract Difference	Actual Cost	Cost Growth
139	$132,680.00	$153,340.00	$20,660.00	$107,736.69	-29.74%
140	$260,875.00	$269,925.00	$9,050.00	$283,713.42	5.11%
141	$358,900.00	$349,914.80	($8,985.20)	$346,213.20	-1.06%
142	$401,418.50	$401,876.80	$458.30	$393,766.35	-2.02%
143	$186,900.00	$196,261.00	$9,361.00	$192,903.40	-1.71%
144	$334,451.00	$332,323.00	($2,128.00)	$323,147.42	-2.76%
145	$608,810.00	$500,682.25	($108,127.75)	$497,549.15	-0.63%
146	$191,220.00	$217,660.00	$26,440.00	$219,255.32	0.73%
147	$0.00	$315,197.00	$315,197.00	$310,997.70	-1.33%
148	$268,045.00	$220,814.00	($47,231.00)	$208,452.95	-5.60%
149	$1,209,980.00	$1,030,439.70	($179,540.30)	$1,025,925.85	-0.44%
150	$735,329.90	$565,601.36	($169,728.54)	$576,817.62	1.98%
151	$229,225.00	$252,324.00	$23,099.00	$252,323.83	0.00%
152	$881,279.00	$937,448.50	$56,169.50	$936,985.27	-0.05%
153	$691,129.20	$596,116.40	($95,012.80)	$588,392.63	-1.30%
154	$0.00	$482,200.00	$482,200.00	$478,745.53	-0.72%
155	$163,753.00	$217,969.70	$54,216.70	$210,355.15	-3.49%
156	$378,032.40	$393,896.92	$15,864.52	$390,703.49	-0.81%
157	$36,023.00	$39,683.58	$3,660.58	$39,589.13	-0.24%
158	$90,509.00	$84,762.32	($5,746.68)	$83,037.49	-2.03%
159	$82,884.00	$76,788.16	($6,095.84)	$74,556.21	-2.91%
160	$154,527.00	$134,946.80	($19,580.20)	$133,881.22	-0.79%
161	$385,695.60	$392,365.40	$6,669.80	$392,285.11	-0.02%
162	$591,171.00	$599,976.91	$8,805.91	$599,833.34	-0.02%
163	$460,308.00	$558,509.80	$98,201.80	$557,475.47	-0.19%
164	$139,990.95	$179,871.85	$39,880.90	$177,603.05	-1.26%
165	$172,550.00	$152,840.50	($19,709.50)	$140,371.41	-8.16%
166	$35,425.25	$60,843.03	$25,417.78	$55,526.92	-8.74%
167	$94,987.50	$66,045.00	($28,942.50)	$65,729.53	-0.48%
168	$389,988.78	$352,866.87	($37,121.91)	$346,942.53	-1.68%
169	$266,536.00	$307,383.75	$40,847.75	$302,254.03	-1.67%
170	$627,200.00	$560,836.00	($66,364.00)	$536,155.50	-4.40%
171	$1,949,791.96	$2,132,314.53	$182,522.57	$1,876,259.78	-12.01%
172	$182,075.00	$135,310.00	($46,765.00)	$134,056.90	-0.93%
173	$223,530.00	$198,224.70	($25,305.30)	$184,954.05	-6.69%
174	$74,600.00	$53,077.90	($21,522.10)	$53,077.90	0.00%
175	$343,052.94	$391,063.33	$48,010.39	$379,915.67	-2.85%
176	$573,905.00	$536,307.80	($37,597.20)	$536,300.37	0.00%
177	$494,039.00	$538,649.00	$44,610.00	$538,040.53	-0.11%
178	$194,600.00	$208,650.00	$14,050.00	$206,179.95	-1.18%
179	$288,218.28	$293,000.00	$4,781.72	$289,198.98	-1.30%
180	$755,200.00	$781,886.46	$26,686.46	$772,251.91	-1.23%
181	$524,898.40	$490,537.20	($34,361.20)	$493,823.90	0.67%
182	$667,050.00	$599,439.40	($67,610.60)	$603,156.05	0.62%
183	$498,304.00	$539,600.84	$41,296.84	$528,092.59	-2.13%
184	$664,886.25	$490,967.20	($173,919.05)	$477,245.04	-2.79%

ID	Duration	Contractor	Number of Projects
139	72	The Quapaw Company	10
140	159	The Cummins Construction Co., Inc.	35
141	77	Tri-State Asphalt, Inc.	3
142	202	Vinita Rock Company	7
143	39	Vinita Rock Company	7
144	191	Romine Construction Co.	1
145	23	Shears Construction Co.	19
146	87	Bellco Materials, Inc.	16
147	68	S. G. & S. Construction, Inc.	2
148	53	Vinita Rock Company	7
149	107	APAC-Oklahoma, Inc.	7
150	403	Becco Contractors, Inc.	1
151	158	J. H. Shears' Sons, Inc.	1
152	150	Highway Contractors, Inc.	8
153	60	J. & R. Sand Company, Inc.	3
154	199	Broce Const. Co., Inc.	18
155	115	Shears Construction Co.	19
156	117	Interstate Contracting Corp.	2
157	30	Job Construction Co., Inc.	12
158	347	Job Construction Co., Inc.	12
159	74	Job Construction Co., Inc.	12
160	206	Glover Construction Co., Inc.	30
161	114	Broce Const. Co., Inc.	18
162	102	Broce Const. Co., Inc.	18
163	80	Broce Const. Co., Inc.	18
164	47	The Cummins Construction Co., Inc.	35
165	30	Broce Const. Co., Inc.	18
166	30	OBC, Inc.	1
167	30	Circle S Paving Co., Inc.	4
168	139	Bellco Materials, Inc.	16
169	127	Empire Construction & Materials, Inc.	6
170	195	Empire Construction & Materials, Inc.	6
171	101	Empire Construction & Materials, Inc.	6
172	431	APAC-Oklahoma, Inc.	7
173	77	T & G Construction Co., Inc.	6
174	72	Shears Construction Co.	19
175	98	T & G Construction Co., Inc.	6
176	108	Highway Contractors, Inc.	8
177	82	Highway Contractors, Inc.	8
178	206	Tiger Ind. Transp. Sys., Inc.	4
179	68	Forsgren, Inc.	1
180	180	Shears Construction Co.	19
181	44	Bellco Materials, Inc.	16
182	112	Bellco Materials, Inc.	16
183	90	The Cummins Construction Co., Inc.	35
184	90	Northern Improvement Company	3

ID	Total Cost Growth	Resident Engineer	Weather	No of Bad Weather Days
139	-0.13z		No	0
140	-0.57ae		Yes	37
141	-0.1am		No	0
142	-0.28am		Yes	48
143	-0.28am		Yes	43
144	-0.03r		No	0
145	-0.21aq		No	0
146	0.33am		Yes	51
147	0.04b		No	0
148	-0.28b		No	0
149	-0.31ae		No	0
150	0.02ae		No	0
151	0m		Yes	43
152	-0.01ai		No	0
153	0ai		No	0
154	-0.35w		No	0
155	-0.21w		No	0
156	0.03w		Yes	61
157	-0.09ak		No	0
158	-0.09c		Yes	34
159	-0.09c		No	0
160	0.72c		Yes	36
161	-0.35h		No	0
162	-0.35j		No	0
163	-0.35h		No	0
164	-0.57h		Yes	61
165	-0.35h		Yes	52
166	-0.09h		No	0
167	-0.05aq		No	0
168	0.33ae		Yes	36
169	-0.21aj		No	0
170	-0.21b		No	0
171	-0.21o		No	0
172	-0.31o		Yes	61
173	-0.2m		Yes	30
174	-0.21m		No	0
175	-0.2m		No	0
176	-0.01ai		Yes	29
177	-0.01ai		No	0
178	-0.05ak		Yes	4
179	-0.01ak		No	0
180	-0.21x		Yes	56
181	0.33am		No	0
182	0.33am		No	0
183	-0.57x		No	0
184	-0.05ap		No	0

ID	Bad weather Days Ratio	Bidding Environment	Plans Review Time	Unit System
139	0.000020		21	English
140	0.232711		21	English-Metric
141	0.000011		21	English-Metric
142	0.237620		21	English
143	1.102620		21	English
144	0.00004		21	English
145	0.000011		21	English-Metric
146	0.586211		21	English-Metric
147	0.00006		21	English
148	0.00009		21	English
149	0.000012		21	English
150	0.000027		21	English
151	0.27229		21	English
152	0.000021		21	English
153	0.000012		21	English
154	0.00006		21	English
155	0.000027		21	English
156	0.521420		21	English
157	0.00002		21	English-Metric
158	0.098012		21	English
159	0.000020		21	English
160	0.17482		21	English
161	0.000011		21	English-Metric
162	0.000026		21	English-Metric
163	0.00006		21	English-Metric
164	1.29792		21	English-Metric
165	1.733337		21	English-Metric
166	0.000011		21	English-Metric
167	0.000011		21	English-Metric
168	0.259011		21	English-Metric
169	0.00004		21	English-Metric
170	0.000026		21	English-Metric
171	0.00007		21	English-Metric
172	0.141511		21	English-Metric
173	0.389611		21	English-Metric
174	0.000011		21	English-Metric
175	0.000026		21	English-Metric
176	0.26852		21	English-Metric
177	0.000026		21	English-Metric
178	0.01947		21	English-Metric
179	0.00007		21	English-Metric
180	0.311119		21	English-Metric
181	0.00009		21	English-Metric
182	0.000026		21	English-Metric
183	0.00009		21	English-Metric
184	0.000026		21	English-Metric

ID	Out-of-State Firms	Work Order Date	Timing of Work Order	Contractors History
139	No	6/15/95	84	Yes
140	No	4/23/96	33	Yes
141	No	6/5/97	42	No
142	No	5/4/95	42	No
143	No	5/9/95	47	No
144	No	9/5/95	40	No
145	Yes	9/9/96	46	Yes
146	No	4/22/96	32	Yes
147	No	9/27/95	34	Yes
148	Yes	6/15/95	112	No
149	Yes	6/30/95	36	Yes
150	No	8/23/95	125	Yes
151	No	3/27/95	32	No
152	No	8/8/95	47	Yes
153	Yes	7/19/95	55	Yes
154	No	10/3/95	40	Yes
155	No	5/24/95	34	Yes
156	No	4/28/95	36	Yes
157	No	10/23/97	28	No
158	Yes	6/27/95	33	No
159	Yes	6/15/95	84	No
160	Yes	1/12/96	57	Yes
161	No	5/21/97	27	Yes
162	No	7/11/96	21	Yes
163	No	6/20/97	29	Yes
164	No	11/6/97	42	Yes
165	No	8/28/97	35	Yes
166	No	6/5/97	42	No
167	No	8/30/96	36	Yes
168	No	3/13/97	21	Yes
169	Yes	9/27/96	36	No
170	Yes	7/31/96	41	No
171	No	8/22/97	29	No
172	No	8/22/96	28	Yes
173	No	3/27/97	35	Yes
174	No	8/28/96	34	Yes
175	Yes	7/26/96	36	Yes
176	No	12/3/97	41	Yes
177	No	7/19/96	29	Yes
178	Yes	8/26/97	33	No
179	Yes	8/20/97	27	No
180	No	4/22/97	26	Yes
181	No	7/17/97	21	Yes
182	No	7/26/96	36	Yes
183	No	5/6/97	40	Yes
184	Yes	8/6/96	47	No

ID	Projects with Overrun	Average No of Projects with O/R	Average Overrun
139	3	0.3000	12.5000
140	10	0.2857	2.8000
141	0	0.0000	0.0000
142	0	0.0000	0.0000
143	0	0.0000	0.0000
144	0	0.0000	0.0000
145	3	0.1579	7.2733
146	5	0.3125	9.2540
147	1	0.5000	5.1700
148	0	0.0000	0.0000
149	1	0.1429	1.2200
150	1	1.0000	1.9800
151	0	0.0000	0.0000
152	1	0.1250	0.0000
153	1	0.3333	1.8600
154	1	0.0556	1.9000
155	3	0.1579	7.2733
156	1	0.5000	4.1100
157	0	0.0000	0.0000
158	0	0.0000	0.0000
159	0	0.0000	0.0000
160	11	0.3667	14.2400
161	1	0.0556	1.9000
162	1	0.0556	1.9000
163	1	0.0556	1.9000
164	10	0.2857	2.8000
165	1	0.0556	1.9000
166	0	0.0000	0.0000
167	1	0.2500	0.0200
168	5	0.3125	9.2540
169	0	0.0000	0.0000
170	0	0.0000	0.0000
171	0	0.0000	0.0000
172	1	0.1429	1.2200
173	1	0.1667	12.1100
174	3	0.1579	7.2733
175	1	0.1667	12.1100
176	1	0.1250	0.0000
177	1	0.1250	0.0000
178	0	0.0000	0.0000
179	0	0.0000	0.0000
180	3	0.1579	7.2733
181	5	0.3125	9.2540
182	5	0.3125	9.2540
183	10	0.2857	2.8000
184	0	0.0000	0.0000

ID	Average Cost Growth	Availability of Labor
139	-0.0130	4.9
140	-0.0163	4.1
141	-0.0333	3.8
142	-0.0400	4.9
143	-0.0400	4.9
144	-0.0300	4.6
145	-0.0111	4.6
146	0.0206	4.1
147	0.0200	4.3
148	-0.0400	5.5
149	-0.0443	4.9
150	0.0200	4.6
151	0.0000	5.5
152	-0.0012	4.8
153	0.0000	4.9
154	-0.0194	4.3
155	-0.0111	4.6
156	0.0150	4.9
157	-0.0075	4.1
158	-0.0075	4.9
159	-0.0075	4.9
160	0.0240	4.1
161	-0.0194	3.8
162	-0.0194	4
163	-0.0194	4.2
164	-0.0163	4.1
165	-0.0194	4
166	-0.0900	3.8
167	-0.0125	3.8
168	0.0206	4.4
169	-0.0350	3.6
170	-0.0350	4
171	-0.0350	4
172	-0.0443	3.8
173	-0.0333	4.4
174	-0.0111	3.8
175	-0.0333	4
176	-0.0012	4.1
177	-0.0012	4
178	-0.0125	4
179	-0.0100	4
180	-0.0111	4
181	0.0206	4.2
182	0.0206	4
183	-0.0163	4
184	-0.0167	4

ID	Project No	Location (County)	Project Type	Letting Date	Number of Bids
185	161N(28)	Pittsburg	Resurfacing	11/20/97	3
186	160B(12)	Payne	Resurfacing	7/24/97	1
187	160C(008)	Payne	Resurfacing	3/27/97	2
188	160D(005)	Payne	Resurfacing	4/24/97	1
189	159C(004)	Pawnee	Resurfacing	2/20/97	4
190	158B(004)	Ottawa	Resurfacing	6/26/97	2
191	158C(002)	Ottawa	Resurfacing	7/25/96	3
192	158B(001)	Ottawa	Resurfacing	6/20/96	2
193	157N(007)	Osage	Resurfacing	6/26/97	1
194	157C(006)	Osage	Resurfacing	4/24/97	4
195	157B(003)	Osage	Resurfacing	7/25/96	5
196	156N(017)	Okmulgee	Resurfacing	4/23/98	0
197	156N(3)	Okmulgee	Resurfacing	6/20/96	3
198	155N(026)	Oklahoma	Resurfacing	7/24/97	2
199	154C(001)	Okfuskee	Resurfacing	6/20/96	3
200	152C(008)	Noble	Resurfacing	5/22/97	0
201	152B(007)	Noble	Resurfacing	5/22/97	0
202	151B(46)	Muskogee	Resurfacing	6/25/98	3
203	151B(035)	Muskogee	Surfacing	10/23/97	4
204	151D(18)	Muskogee	Resurfacing	1/22/98	0
205	151N(012)	Muskogee	Resurfacing	6/20/96	2
206	150D(002)	Murray	Resurfacing	1/23/97	4
207	149N(004)	Mayes	Resurfacing	2/20/97	5
208	149B(002)	Mayes	Resurfacing	6/20/96	4
209	148D(006)	Marshall	Resurfacing	1/23/97	3
210	148D(005)	Marshall	Resurfacing	1/23/97	4
211	147N(002)	Major	Resurfacing	5/22/97	1
212	146C(006)	Mcintosh	Resurfacing	6/26/97	3
213	146C(005)	Mcintosh	Resurfacing	8/22/96	3
214	146N(004)	Mcintosh	Resurfacing	6/20/96	2
215	145A(26)	McCurtain	Resurfacing	5/21/98	3
216	145N(018)	McCurtain	Resurfacing	2/19/98	2
217	145N(003)	McCurtain	Resurfacing	11/21/96	2
218	144C(13)	McClain	Resurfacing	3/26/98	4
219	144D(012)	McClain	Resurfacing	7/24/97	4
220	144C(7)	McClain	Resurfacing	6/20/96	6
221	142C(004)	Logan	Resurfacing	3/27/97	3
222	136B(007)	Kay	Resurfacing	5/22/97	0
223	136D(005)	Kay	Surfacing	8/22/96	2
224	135C(06)	Johnson	Resurfacing	6/26/97	3
225	135B(001)	Johnson	Resurfacing	6/20/96	5
226	133N(004)	Jackson	Resurfacing	6/20/96	4
227	132D(002)	Hughes	Surfacing	8/22/96	3
228	131B(12)	Haskell	Resurfacing	8/21/97	3
229	130B(003)	Harper	Resurfacing	7/25/96	1
230	128B(10)	Greer	Resurfacing	6/26/97	7

ID	Lowest Bid	2nd Lowest Bid	Highest Bid	MLOT	Bid Range
185	$635,442.50	$667,428.20	$695,847.00	$31,985.70	$60,404.50
186	$1,228,850.00	$1,228,850.00	$1,228,850.00	$0.00	$0.00
187	$429,080.00	$435,830.00	$435,830.00	$6,750.00	$6,750.00
188	$272,665.00	$272,665.00	$272,665.00	$0.00	$0.00
189	$511,354.05	$538,273.90	$620,669.09	$26,919.85	$109,315.04
190	$117,837.70	$139,337.60	$139,337.60	$21,499.90	$21,499.90
191	$377,052.00	$429,855.75	$455,592.54	$52,803.75	$78,540.54
192	$507,211.25	$633,450.50	$633,450.50	$126,239.25	$126,239.25
193	$758,695.00	$758,695.00	$758,695.00	$0.00	$0.00
194	$597,184.50	$735,873.75	$829,531.25	$138,689.25	$232,346.75
195	$474,868.25	$498,750.75	$617,624.20	$23,882.50	$142,755.95
196	$0.00	$0.00	$0.00	$0.00	$0.00
197	$908,167.40	$992,989.45	$1,119,485.50	$84,822.05	$211,318.10
198	$127,535.00	$150,855.00	$150,855.00	$23,320.00	$23,320.00
199	$270,211.50	$284,923.10	$291,577.50	$14,711.60	$21,366.00
200	$0.00	$0.00	$0.00	$0.00	$0.00
201	$0.00	$0.00	$0.00	$0.00	$0.00
202	$484,900.00	$513,500.00	$528,635.00	$28,600.00	$43,735.00
203	$229,913.30	$248,272.10	$290,573.00	$18,358.80	$60,659.70
204	$0.00	$0.00	$0.00	$0.00	$0.00
205	$350,430.00	$388,370.00	$388,370.00	$37,940.00	$37,940.00
206	$272,585.76	$317,047.50	$393,192.96	$44,461.74	$120,607.20
207	$333,110.51	$355,576.97	$387,147.74	$22,466.46	$54,037.23
208	$134,364.00	$135,488.00	$182,210.00	$1,124.00	$47,846.00
209	$41,249.40	$47,575.30	$49,684.56	$6,325.90	$8,435.16
210	$159,788.56	$195,328.30	$255,053.40	$35,539.74	$95,264.84
211	$212,021.05	$212,021.05	$212,021.05	$0.00	$0.00
212	$161,755.00	$191,900.00	$223,715.00	$30,145.00	$61,960.00
213	$116,289.00	$129,720.00	$136,901.50	$13,431.00	$20,612.50
214	$124,350.00	$155,150.00	$155,150.00	$30,800.00	$30,800.00
215	$509,683.50	$544,200.80	$613,580.00	$34,517.30	$103,896.50
216	$297,762.56	$318,606.80	$318,606.80	$20,844.24	$20,844.24
217	$319,543.84	$368,587.85	$368,587.85	$49,044.01	$49,044.01
218	$559,525.00	$581,704.63	$838,422.76	$22,179.63	$278,897.76
219	$203,302.46	$227,010.99	$248,279.90	$23,708.53	$44,977.44
220	$722,514.07	$787,558.17	$909,557.76	$65,044.10	$187,043.69
221	$295,500.00	$339,970.00	$363,700.00	$44,470.00	$68,200.00
222	$0.00	$0.00	$0.00	$0.00	$0.00
223	$44,277.00	$59,750.00	$59,750.00	$15,473.00	$15,473.00
224	$560,823.00	$625,119.00	$680,092.65	$64,296.00	$119,269.65
225	$277,081.84	$305,787.99	$351,414.11	$28,706.15	$74,332.27
226	$390,522.90	$392,462.33	$438,378.62	$1,939.43	$47,855.72
227	$46,354.40	$49,887.00	$62,480.30	$3,532.60	$16,125.90
228	$496,655.00	$506,642.50	$516,100.00	$9,987.50	$19,445.00
229	$90,765.40	$90,765.40	$90,765.40	$0.00	$0.00
230	$667,175.20	$759,617.00	$948,660.00	$92,441.80	$281,484.80

ID	Engr's Estimate	Contract Amount	Contract Difference	Actual Cost	Cost Growth
185	$637,502.00	$635,442.50	($2,059.50)	$620,027.26	-2.43%
186	$1,102,390.00	$1,228,850.00	$126,460.00	$1,188,599.06	-3.28%
187	$358,780.00	$429,080.00	$70,300.00	$434,312.48	1.22%
188	$304,640.00	$272,665.00	($31,975.00)	$324,826.27	19.13%
189	$533,649.68	$511,354.05	($22,295.63)	$495,504.34	-3.10%
190	$127,072.60	$117,837.70	($9,234.90)	$117,463.81	-0.32%
191	$496,503.00	$377,052.00	($119,451.00)	$370,597.90	-1.71%
192	$563,000.00	$507,211.25	($55,788.75)	$502,569.88	-0.92%
193	$749,260.00	$758,695.00	$9,435.00	$747,270.30	-1.51%
194	$631,073.50	$597,184.50	($33,889.00)	$587,865.73	-1.56%
195	$560,450.00	$474,868.25	($85,581.75)	$472,515.31	-0.50%
196	$0.00	$178,764.00	$178,764.00	$159,390.78	-10.84%
197	$1,187,710.00	$908,167.40	($279,542.60)	$893,511.94	-1.61%
198	$117,869.00	$127,535.00	$9,666.00	$108,331.82	-15.06%
199	$250,656.50	$270,211.50	$19,555.00	$279,651.07	3.49%
200	$0.00	$514,894.60	$514,894.60	$572,746.83	11.24%
201	$0.00	$533,536.00	$533,536.00	$709,629.83	33.01%
202	$453,775.00	$484,900.00	$31,125.00	$419,002.66	-13.59%
203	$268,825.50	$229,913.30	($38,912.20)	$244,742.30	6.45%
204	$0.00	$25,449.85	$25,449.85	$24,969.03	-1.89%
205	$401,400.00	$350,430.00	($50,970.00)	$232,787.91	-33.57%
206	$292,017.30	$272,585.76	($19,431.54)	$242,614.63	-11.00%
207	$381,265.52	$333,110.51	($48,155.01)	$332,496.82	-0.18%
208	$148,895.00	$134,364.00	($14,531.00)	$126,130.49	-6.13%
209	$42,166.40	$41,249.40	($917.00)	$40,888.18	-0.88%
210	$189,972.25	$159,788.56	($30,183.69)	$158,404.88	-0.87%
211	$191,493.68	$212,021.05	$20,527.37	$227,369.47	7.24%
212	$176,700.00	$161,755.00	($14,945.00)	$161,664.74	-0.06%
213	$116,068.00	$116,289.00	$221.00	$115,296.57	-0.85%
214	$139,000.00	$124,350.00	($14,650.00)	$236,888.85	90.50%
215	$503,236.80	$509,683.50	$6,446.70	$502,570.06	-1.40%
216	$264,234.00	$297,962.56	$33,728.56	$296,656.13	-0.44%
217	$302,835.98	$319,543.84	$16,707.86	$321,577.11	0.64%
218	$507,693.25	$559,525.00	$51,831.75	$554,427.60	-0.91%
219	$205,800.58	$203,302.46	($2,498.12)	$198,316.75	-2.45%
220	$830,922.10	$722,514.07	($108,408.03)	$717,420.35	-0.70%
221	$245,200.00	$295,500.00	$50,300.00	$293,683.60	-0.61%
222	$0.00	$945,665.00	$945,665.00	$928,844.88	-1.78%
223	$49,525.00	$44,277.00	($5,248.00)	$41,919.00	-5.33%
224	$533,314.00	$560,823.00	$27,509.00	$567,179.65	1.13%
225	$364,951.35	$277,081.84	($87,869.51)	$273,562.49	-1.27%
226	$413,069.00	$390,522.90	($22,546.10)	$383,981.90	-1.67%
227	$49,127.75	$46,354.40	($2,773.35)	$48,274.74	4.14%
228	$475,200.00	$496,655.00	$21,455.00	$483,172.28	-2.71%
229	$84,628.00	$90,765.40	$6,137.40	$106,179.60	16.98%
230	$834,416.00	$667,175.20	($167,240.80)	$723,763.27	8.48%

ID	Duration	Contractor	Number of Projects
185	60	The Cummins Construction Co., Inc.	35
186	323	The Quapaw Company	10
187	38	APAC-Oklahoma, Inc.	7
188	47	The Quapaw Company	10
189	151	Bellco Materials, Inc.	16
190	58	Vinita Rock Company	7
191	48	Masters-Jackson Paving Co.	2
192	338	Vinita Rock Company	7
193	64	Bellco Materials, Inc.	16
194	133	Bellco Materials, Inc.	16
195	68	Bellco Materials, Inc.	16
196	43	APAC-Oklahoma, Inc.	7
197	124	Empire Construction & Materials, Inc.	6
198	95	Haskell Lemon Construction Co.	11
199	60	Glover Construction Co., Inc.	30
200	161	Bellco Materials, Inc.	16
201	148	Bellco Materials, Inc.	16
202	45	Vinita Rock Company	7
203	186	Glover Construction Co., Inc.	30
204	128	Glover Construction Co., Inc.	30
205	388	Glover Construction Co., Inc.	30
206	74	Overland Corporation	5
207	143	Empire Construction & Materials, Inc.	6
208	53	Glover Construction Co., Inc.	30
209	69	Overland Corporation	5
210	60	Overland Corporation	5
211	79	The Cummins Construction Co., Inc.	35
212	244	Glover Construction Co., Inc.	30
213	52	Tiger Ind. Transp. Sys., Inc.	4
214	156	Glover Construction Co., Inc.	30
215	73	Glover Construction Co., Inc.	30
216	84	Glover Construction Co., Inc.	30
217	218	Glover Construction Co., Inc.	30
218	60	Haskell Lemon Construction Co.	11
219	30	Haskell Lemon Construction Co.	11
220	90	Shears Construction Co.	19
221	77	T. J. Campbell Const. Co.	3
222	228	Pavers, Inc.	1
223	50	Evans & Associates Const.	4
224	60	The Cummins Construction Co., Inc.	35
225	60	Northern Improvement Company	3
226	309	Shears Construction Co.	19
227	31	Shears Construction Co.	19
228	72	Glover Construction Co., Inc.	30
229	63	Behne Construction Co., Inc.	1
230	398	Cornell Constr. Co., Inc.	8

ID	Total Cost Growth	Resident Engineer	Weather	No of Bad Weather Days
185	-0.57 y		Yes	61
186	-0.13 z		Yes	61
187	-0.31 z		Yes	55
188	-0.13 z		No	0
189	0.33 ae		Yes	36
190	-0.28 am		No	0
191	-0.02 am		No	0
192	-0.28 am		Yes	61
193	0.33 ae		No	0
194	0.33 ae		Yes	22
195	0.33 ae		No	0
196	-0.31 aj		No	0
197	-0.21 b		No	0
198	-0.48 v		No	0
199	0.72 al		No	0
200	0.33 f		No	0
201	0.33 f		No	0
202	-0.28 aj		No	0
203	0.72 aj		Yes	61
204	0.72 o		Yes	61
205	0.72 b		Yes	61
206	-0.29 ad		Yes	61
207	-0.21 am		No	0
208	0.72 am		No	0
209	-0.29 ag		Yes	61
210	-0.29 ag		Yes	61
211	-0.57 h		No	0
212	0.72 aj		No	0
213	-0.05 aj		No	0
214	0.72 b		No	0
215	0.72 d		No	0
216	0.72 d		Yes	61
217	0.72 d		Yes	61
218	-0.48 p		No	0
219	-0.48 p		No	0
220	-0.21 p		No	0
221	-0.31 z		No	0
222	-0.02 f		No	0
223	-0.15 ah		No	0
224	-0.57 af		No	0
225	-0.05 ap		No	0
226	-0.21 m		Yes	61
227	-0.21 l		No	0
228	0.72 ak		Yes	46
229	0.17 j		No	0
230	0.22 aq		No	0

ID	Bad weather Days Ratio	Bidding Environment	Plans Review Time	Unit System
185	1.01671		21	English-Metric
186	0.18897		21	English-Metric
187	1.44749		21	English-Metric
188	0.000011		21	English-Metric
189	0.238411		21	English-Metric
190	0.00009		21	English-Metric
191	0.000011		21	English-Metric
192	0.180526		21	English-Metric
193	0.00009		21	English-Metric
194	0.165411		21	English-Metric
195	0.000011		21	English-Metric
196	0.00002		21	English-Metric
197	0.000026		21	English-Metric
198	0.00007		21	English-Metric
199	0.000026		21	English-Metric
200	0.00006		21	English-Metric
201	0.00006		21	English-Metric
202	0.00001		21	English-Metric
203	0.32802		21	English-Metric
204	0.47661		21	English-Metric
205	0.157226		21	English-Metric
206	0.82435		21	English-Metric
207	0.000011		21	English-Metric
208	0.000026		21	English-Metric
209	0.88415		21	English-Metric
210	1.01675		21	English-Metric
211	0.00006		21	English-Metric
212	0.00009		21	English-Metric
213	0.00004		21	English-Metric
214	0.000026		21	English-Metric
215	0.00002		21	English-Metric
216	0.726223		21	English-Metric
217	0.27981		21	English-Metric
218	0.00003		21	English-Metric
219	0.00007		21	English-Metric
220	0.000026		21	English-Metric
221	0.00009		21	English-Metric
222	0.00006		21	English-Metric
223	0.00004		21	English-Metric
224	0.00009		21	English-Metric
225	0.000026		21	English-Metric
226	0.197426		21	English-Metric
227	0.00004		21	English-Metric
228	0.63891		21	English-Metric
229	0.000011		21	English-Metric
230	0.00009		21	English-Metric

ID	Out-of-State Firms	Work Order Date	Timing of Work Order	Contractors History
185	No	12/19/97	29	Yes
186	No	9/9/97	47	Yes
187	No	5/5/97	39	Yes
188	No	5/28/97	34	Yes
189	No	3/13/97	21	Yes
190	No	7/18/97	22	No
191	No	9/9/96	46	No
192	No	7/24/96	34	No
193	No	7/17/97	21	Yes
194	No	5/14/97	20	Yes
195	No	8/22/96	28	Yes
196	No	6/2/98	40	Yes
197	No	7/24/96	34	No
198	No	8/26/97	33	Yes
199	Yes	7/29/96	39	Yes
200	No	6/12/97	21	Yes
201	No	6/12/97	21	Yes
202	Yes	7/23/98	28	No
203	No	12/4/97	42	Yes
204	No	3/4/98	41	Yes
205	Yes	7/29/96	39	Yes
206	Yes	2/26/97	34	No
207	No	3/24/97	32	No
208	No	7/29/96	39	Yes
209	Yes	2/27/97	35	No
210	Yes	2/27/97	35	No
211	No	6/26/97	35	Yes
212	No	7/18/97	22	Yes
213	No	9/23/96	32	No
214	Yes	7/29/96	39	Yes
215	No	6/22/98	32	Yes
216	No	3/19/98	28	Yes
217	No	12/19/96	28	Yes
218	No	4/30/98	35	Yes
219	No	9/25/97	63	Yes
220	No	7/31/96	41	Yes
221	No	5/5/97	39	No
222	No	6/20/97	29	No
223	No	9/17/96	26	No
224	No	7/17/97	21	Yes
225	Yes	8/6/96	47	No
226	No	7/29/96	39	Yes
227	No	9/27/96	36	Yes
228	No	9/24/97	34	Yes
229	No	8/29/96	35	Yes
230	No	7/15/97	19	Yes

ID	Projects with Overrun	Average No of Projects with O/R	Average Overrun
185	10	0.2857	2.8000
186	3	0.3000	12.5000
187	1	0.1429	1.2200
188	3	0.3000	12.5000
189	5	0.3125	9.2540
190	0	0.0000	0.0000
191	0	0.0000	0.0000
192	0	0.0000	0.0000
193	5	0.3125	9.2540
194	5	0.3125	9.2540
195	5	0.3125	9.2540
196	1	0.1429	1.2200
197	0	0.0000	0.0000
198	2	0.1818	2.6800
199	11	0.3667	14.2400
200	5	0.3125	9.2540
201	5	0.3125	9.2540
202	0	0.0000	0.0000
203	11	0.3667	14.2400
204	11	0.3667	14.2400
205	11	0.3667	14.2400
206	0	0.0000	0.0000
207	0	0.0000	0.0000
208	11	0.3667	14.2400
209	0	0.0000	0.0000
210	0	0.0000	0.0000
211	10	0.2857	2.8000
212	11	0.3667	14.2400
213	0	0.0000	0.0000
214	11	0.3667	14.2400
215	11	0.3667	14.2400
216	11	0.3667	14.2400
217	11	0.3667	14.2400
218	2	0.1818	2.6800
219	2	0.1818	2.6800
220	3	0.1579	7.2733
221	0	0.0000	0.0000
222	0	0.0000	0.0000
223	0	0.0000	0.0000
224	10	0.2857	2.8000
225	0	0.0000	0.0000
226	3	0.1579	7.2733
227	3	0.1579	7.2733
228	11	0.3667	14.2400
229	1	1.0000	16.9800
230	4	0.5000	7.1575

ID	Average Cost Growth	Availability of Labor
185	-0.0163	3.9
186	-0.0130	4
187	-0.0443	4
188	-0.0130	3.8
189	0.0206	4.4
190	-0.0400	4.2
191	-0.0100	3.8
192	-0.0400	4
193	0.0206	4.2
194	0.0206	3.8
195	0.0206	3.8
196	-0.0443	4.4
197	-0.0350	4
198	-0.0436	4
199	0.0240	4
200	0.0206	4.2
201	0.0206	4.2
202	-0.0400	4.7
203	0.0240	4.1
204	0.0240	4.7
205	0.0240	4
206	-0.0580	4.8
207	-0.0350	4.4
208	0.0240	4
209	-0.0580	4.8
210	-0.0580	4.8
211	-0.0163	4.2
212	0.0240	4.2
213	-0.0125	3.6
214	0.0240	4
215	0.0240	4.6
216	0.0240	4.9
217	0.0240	3.7
218	-0.0436	4.5
219	-0.0436	4
220	-0.0111	4
221	-0.1033	4
222	-0.0200	4.2
223	-0.0375	3.6
224	-0.0163	4.2
225	-0.0167	4
226	-0.0111	4
227	-0.0111	3.6
228	0.0240	3.8
229	0.1700	3.8
230	0.0275	4.2

ID	Project No	Location (County)	Project Type	Letting Date	Number of Bids
231	127B(008)	Grant	Resurfacing	4/24/97	1
232	126D(004)	Grady	Resurfacing	3/27/97	3
233	124C(002)	Garfield	Resurfacing	3/27/97	1
234	123B(001)	Ellis	Resurfacing	6/20/96	2
235	121B(11)	Delaware	Resurfacing	6/26/97	4
236	120D(010)	Custer	Resurfacing	3/26/98	3
237	120C(1)	Custer	Resurfacing	6/20/96	2
238	119C(005)	Creek	Resurfacing	2/20/97	1
239	119C(004)	Creek	Resurfacing	2/20/97	1
240	119C(004)	Creek	Resurfacing	2/20/97	1
241	115B(006)	Coal	Resurfacing	6/26/97	3
242	115N(005)	Coal	Resurfacing	3/27/97	3
243	115D(002)	Coal	Resurfacing	4/24/97	2
244	113A(003)	Cimarron	Resurfacing	6/20/96	1
245	111D(017)	Cherokee	Resurfacing	5/21/98	0
246	111C(13)	Cherokee	Resurfacing	4/24/97	4
247	110D(003)	Carter	Resurfacing	2/20/97	2
248	110D(002)	Carter	Resurfacing	2/20/97	2
249	109A(005)	Canadian	Resurfacing	3/27/97	2
250	109C(06)	Canadian	Resurfacing	3/27/97	2
251	108B(014)	Caddo	Resurfacing	4/24/97	3
252	108(002)	LeFlore	Overlay	5/25/95	1
253	108(002)	LeFlore	Overlay	5/25/95	1
254	108(002)	LeFlore	Overlay	5/25/95	1
255	108(002)	LeFlore	Overlay	5/25/95	1
256	108(002)	LeFlore	Overlay	5/25/95	1
257	108N(001)	Caddo	Resurfacing	6/20/96	3
258	106D(16)	Blaine	Resurfacing	3/26/98	4
259	106D(008)	Blaine	Resurfacing	2/19/98	2
260	106C(002)	Blaine	Resurfacing	2/20/97	3
261	105C(15)	Beckham	Resurfacing	6/26/97	6
262	105B(14)	Beckham	Resurfacing	2/20/97	1
263	104B(008)	Beaver	Resurfacing	2/19/98	2
264	103N(017)	Atoka	Resurfacing	4/23/98	0
265	102C(006)	Alfalfa	Resurfacing	5/22/97	0
266	102C(002)	Alfalfa	Resurfacing	6/20/96	1

ID	Lowest Bid	2nd Lowest Bid	Highest Bid	MLOT	Bid Range
231	$239,080.00	$239,080.00	$239,080.00	$0.00	$0.00
232	$84,694.40	$93,717.81	$155,456.00	$9,023.41	$70,761.60
233	$463,065.00	$463,065.00	$463,065.00	$0.00	$0.00
234	$314,860.75	$337,741.75	$337,741.75	$22,881.00	$22,881.00
235	$862,339.95	$880,385.75	$900,900.75	$18,045.80	$38,560.80
236	$116,767.60	$145,745.00	$159,390.90	$28,977.40	$42,623.30
237	$1,176,889.53	$1,229,166.15	$1,229,166.15	$52,276.62	$52,276.62
238	$319,285.90	$319,285.90	$319,285.90	$0.00	$0.00
239	$176,597.30	$176,597.30	$176,597.30	$0.00	$0.00
240	$294,266.10	$294,266.10	$294,266.10	$0.00	$0.00
241	$598,378.50	$740,690.00	$794,656.00	$142,311.50	$196,277.50
242	$789,329.77	$836,123.18	$998,591.64	$46,793.41	$209,261.87
243	$82,631.93	$99,173.40	$99,173.40	$16,541.47	$16,541.47
244	$265,585.50	$265,585.50	$265,585.50	$0.00	$0.00
245	$0.00	$0.00	$0.00	$0.00	$0.00
246	$301,977.75	$310,713.75	$386,388.00	$8,736.00	$84,410.25
247	$31,483.85	$53,319.30	$53,319.30	$21,835.45	$21,835.45
248	$179,860.38	$189,807.90	$189,807.90	$9,947.52	$9,947.52
249	$141,540.00	$196,650.00	$196,650.00	$55,110.00	$55,110.00
250	$339,415.00	$346,810.00	$346,810.00	$7,395.00	$7,395.00
251	$416,637.41	$423,954.75	$481,269.58	$7,317.34	$64,632.17
252	$321,756.95	$321,756.95	$321,756.95	$0.00	$0.00
253	$350,524.41	$350,524.41	$350,524.41	$0.00	$0.00
254	$203,939.55	$203,939.55	$203,939.55	$0.00	$0.00
255	$366,892.80	$366,892.80	$366,892.80	$0.00	$0.00
256	$358,927.80	$358,927.80	$358,927.80	$0.00	$0.00
257	$178,101.84	$206,511.79	$207,391.71	$28,409.95	$29,289.87
258	$207,770.00	$215,800.60	$314,305.00	$8,030.60	$106,535.00
259	$75,985.00	$99,937.50	$99,937.50	$23,952.50	$23,952.50
260	$491,838.65	$562,305.89	$785,043.90	$70,467.24	$293,205.25
261	$372,802.98	$437,497.00	$509,314.00	$64,694.02	$136,511.02
262	$372,275.12	$372,275.12	$372,275.12	$0.00	$0.00
263	$719,863.10	$737,777.50	$737,777.50	$17,914.40	$17,914.40
264	$0.00	$0.00	$0.00	$0.00	$0.00
265	$0.00	$0.00	$0.00	$0.00	$0.00
266	$211,626.15	$211,626.15	$211,626.15	$0.00	$0.00

ID	Engr's Estimate	Contract Amount	Contract Difference	Actual Cost	Cost Growth
231	$222,540.00	$239,080.00	$16,540.00	$208,237.68	-12.90%
232	$79,960.96	$84,694.40	$4,733.44	$94,953.85	12.11%
233	$389,900.00	$463,065.00	$73,165.00	$445,068.19	-3.89%
234	$286,005.00	$314,860.75	$28,855.75	$314,785.40	-0.02%
235	$750,405.00	$862,339.95	$111,934.95	$828,235.57	-3.95%
236	$125,610.00	$116,767.60	($8,842.40)	$113,172.44	-3.08%
237	$1,073,453.00	$1,176,889.53	$103,436.53	$1,200,910.13	2.04%
238	$326,161.18	$319,285.90	($6,875.28)	$310,764.64	-2.67%
239	$175,995.92	$176,597.30	$601.38	$165,326.50	-6.38%
240	$289,151.68	$294,266.10	$5,114.42	$276,943.31	-5.89%
241	$560,024.00	$598,378.50	$38,354.50	$589,308.00	-1.52%
242	$834,200.30	$789,329.77	($44,870.53)	$777,198.29	-1.54%
243	$63,016.85	$82,631.93	$19,615.08	$83,702.88	1.30%
244	$245,031.00	$265,585.50	$20,554.50	$265,122.58	-0.17%
245	$0.00	$60,028.90	$60,028.90	$59,157.73	-1.45%
246	$312,500.25	$301,977.75	($10,522.50)	$298,669.59	-1.10%
247	$38,105.26	$31,483.85	($6,621.41)	$27,395.86	-12.98%
248	$173,509.83	$179,860.38	$6,350.55	$173,276.43	-3.66%
249	$168,720.00	$141,540.00	($27,180.00)	$150,950.30	6.65%
250	$341,920.00	$339,415.00	($2,505.00)	$316,573.31	-6.73%
251	$359,128.96	$416,637.41	$57,508.45	$387,021.02	-7.11%
252	$345,952.50	$321,756.95	($24,195.55)	$320,758.37	-0.31%
253	$392,257.50	$350,524.41	($41,733.09)	$350,059.38	-0.13%
254	$228,730.00	$203,939.55	($24,790.45)	$203,407.61	-0.26%
255	$404,610.00	$366,892.80	($37,717.20)	$366,738.68	-0.04%
256	$404,610.00	$358,927.80	($45,682.20)	$358,927.62	0.00%
257	$174,412.00	$178,101.84	$3,689.84	$175,877.82	-1.25%
258	$214,780.00	$207,770.00	($7,010.00)	$207,817.33	0.02%
259	$65,000.00	$75,985.00	$10,985.00	$89,093.69	17.25%
260	$407,966.29	$491,838.65	$83,872.36	$497,180.71	1.09%
261	$455,322.40	$372,802.98	($82,519.42)	$358,253.79	-3.90%
262	$333,141.52	$372,275.12	$39,133.60	$370,684.37	-0.43%
263	$647,862.50	$719,863.10	$72,000.60	$719,082.05	-0.11%
264	$0.00	$197,749.65	$197,749.65	$184,798.72	-6.55%
265	$0.00	$293,030.08	$293,030.08	$292,918.77	-0.04%
266	$186,650.00	$211,626.15	$24,976.15	$211,626.15	0.00%

ID	Duration	Contractor	Number of Projects
231	30	The Cummins Construction Co., Inc.	35
232	76	T & G Construction Co., Inc.	6
233	55	The Cummins Construction Co., Inc.	35
234	95	Broce Const. Co., Inc.	18
235	103	The Cummins Construction Co., Inc.	35
236	66	Circle S Paving Co., Inc.	4
237	139	Comell Constr. Co., Inc.	8
238	121	The Quapaw Company	10
239	114	The Quapaw Company	10
240	107	The Quapaw Company	10
241	50	AMIS/OTAC	4
242	90	AMIS/OTAC	4
243	75	Bryan Adair Const., Co.	1
244	89	Highway Contractors, Inc.	8
245	42	Patton Construction Company	1
246	289	Glover Construction Co., Inc.	30
247	97	Overland Corporation	5
248	164	Overland Corporation	5
249	272	Mcconnell Construction, Inc.	3
250	91	Haskell Lemon Construction Co.	11
251	62	Haskell Lemon Construction Co.	11
252	130	Job Construction Co., Inc.	12
253	130	Job Construction Co., Inc.	12
254	130	Job Construction Co., Inc.	12
255	214	Job Construction Co., Inc.	12
256	214	Job Construction Co., Inc.	12
257	87	Haskell Lemon Construction Co.	11
258	98	Circle S Paving Co., Inc.	4
259	79	Comell Constr. Co., Inc.	8
260	185	The Cummins Construction Co., Inc.	35
261	368	Comell Constr. Co., Inc.	8
262	199	Caswell-Orth Contracting, Inc.	1
263	85	Highway Contractors, Inc.	8
264	62	The Cummins Construction Co., Inc.	35
265	87	Broce Const. Co., Inc.	18
266	75	The Cummins Construction Co., Inc.	35

ID	Total Cost Growth	Resident Engineer	Weather	No of Bad Weather Days
231	-0.57	l	No	0
232	-0.2	n	No	0
233	-0.57	l	No	0
234	-0.35	j	No	0
235	-0.57	am	No	0
236	-0.05	aq	No	0
237	0.22	aq	No	0
238	-0.13	ae	Yes	61
239	-0.13	ae	Yes	61
240	-0.13	ae	Yes	61
241	-0.05	k	Yes	28
242	-0.05	k	Yes	55
243	0.01	k	No	0
244	-0.01	ai	No	0
245	-0.01	aj	No	0
246	0.72	aj	Yes	38
247	-0.29	ad	Yes	61
248	-0.29	ad	No	0
249	0.01	an	No	0
250	-0.48	an	No	0
251	-0.48	n	No	0
252	-0.09	u	Yes	61
253	-0.09	u	Yes	61
254	-0.09	u	Yes	61
255	-0.09	u	No	0
256	-0.09	u	No	0
257	-0.48	an	No	0
258	-0.05	aq	Yes	37
259	0.22	aq	Yes	21
260	-0.57	l	Yes	22
261	0.22	aq	No	0
262	0	aq	Yes	61
263	-0.01	h	Yes	59
264	-0.57	y	No	0
265	-0.35	h	No	0
266	-0.57	j	No	0

ID	Bad weather Days Ratio	Bidding Environment	Plans Review Time	Unit System
231	0.000011		21	English-Metric
232	0.00009		21	English-Metric
233	0.00009		21	English-Metric
234	0.000026		21	English-Metric
235	0.00009		21	English-Metric
236	0.00003		21	English-Metric
237	0.000026		21	English-Metric
238	0.504111		21	English-Metric
239	0.535111		21	English-Metric
240	0.570111		21	English-Metric
241	0.56009		21	English-Metric
242	0.61119		21	English-Metric
243	0.000011		21	English-Metric
244	0.000026		21	English-Metric
245	0.00002		21	English-Metric
246	0.131511		21	English-Metric
247	0.628911		21	English-Metric
248	0.000011		21	English-Metric
249	0.00009		21	English-Metric
250	0.00009		21	English-Metric
251	0.000011		21	English-Metric
252	0.469212		21	English
253	0.469212		21	English
254	0.469212		21	English
255	0.000012		21	English
256	0.000012		21	English
257	0.000026		21	English-Metric
258	0.37763		21	English-Metric
259	0.26583		21	English-Metric
260	0.118911		21	English-Metric
261	0.00009		21	English-Metric
262	0.306511		21	English-Metric
263	0.69413		21	English-Metric
264	0.00002		21	English-Metric
265	0.00006		21	English-Metric
266	0.000026		21	English-Metric

ID	Out-of-State Firms	Work Order Date	Timing of Work Order	Contractors History
231	No	5/22/97	28	Yes
232	No	4/24/97	28	Yes
233	No	5/6/97	40	Yes
234	No	7/11/96	21	Yes
235	No	7/17/97	21	Yes
236	No	5/21/98	56	Yes
237	No	7/23/96	33	Yes
238	No	3/24/97	32	Yes
239	No	3/24/97	32	Yes
240	No	3/24/97	32	Yes
241	No	7/25/97	29	No
242	No	5/5/97	39	No
243	No	6/5/97	42	Yes
244	No	7/19/96	29	Yes
245	No	7/14/98	54	No
246	Yes	5/22/97	28	Yes
247	No	3/20/97	28	No
248	No	3/20/97	28	No
249	No	5/5/97	39	Yes
250	No	4/22/97	26	Yes
251	No	5/19/97	25	Yes
252	No	6/30/95	36	No
253	No	6/30/95	36	No
254	No	6/30/95	36	No
255	No	6/30/95	36	No
256	No	6/30/95	36	No
257	No	7/23/96	33	Yes
258	No	5/6/98	41	Yes
259	No	3/27/98	36	Yes
260	No	3/25/97	33	Yes
261	No	7/14/97	18	Yes
262	No	3/13/97	21	No
263	No	3/18/98	27	Yes
264	No	6/2/98	40	Yes
265	No	6/20/97	29	Yes
266	No	7/31/96	41	Yes

ID	Projects with Overrun	Average No of Projects with O/R	Average Overrun
231	10	0.2857	2.8000
232	1	0.1667	12.1100
233	10	0.2857	2.8000
234	1	0.0556	1.9000
235	10	0.2857	2.8000
236	1	0.2500	0.0200
237	4	0.5000	7.1575
238	3	0.3000	12.5000
239	3	0.3000	12.5000
240	3	0.3000	12.5000
241	0	0.0000	0.0000
242	0	0.0000	0.0000
243	1	1.0000	1.3000
244	1	0.1250	0.0000
245	0	0.0000	0.0000
246	11	0.3667	14.2400
247	0	0.0000	0.0000
248	0	0.0000	0.0000
249	2	0.6667	3.5150
250	2	0.1818	2.6800
251	2	0.1818	2.6800
252	0	0.0000	0.0000
253	0	0.0000	0.0000
254	0	0.0000	0.0000
255	0	0.0000	0.0000
256	0	0.0000	0.0000
257	2	0.1818	2.6800
258	1	0.2500	0.0200
259	4	0.5000	7.1575
260	10	0.2857	2.8000
261	4	0.5000	7.1575
262	0	0.0000	0.0000
263	1	0.1250	0.0000
264	10	0.2857	2.8000
265	1	0.0556	1.9000
266	10	0.2857	2.8000

ID	Average Cost Growth	Availability of Labor
231	-0.0163	3.8
232	-0.0333	4
233	-0.0163	4
234	-0.0194	4
235	-0.0163	4.2
236	-0.0125	4.5
237	0.0275	4
238	-0.0130	4.4
239	-0.0130	4.4
240	-0.0130	4.4
241	-0.0125	4.2
242	-0.0125	4
243	0.0100	3.8
244	-0.0012	4
245	-0.0100	4.6
246	0.0240	3.8
247	-0.0580	4.4
248	-0.0580	4.4
249	0.0033	4
250	-0.0436	4
251	-0.0436	3.8
252	-0.0075	4.9
253	-0.0075	4.9
254	-0.0075	4.9
255	-0.0075	4.9
256	-0.0075	4.9
257	-0.0436	4
258	-0.0125	4.5
259	0.0275	4.9
260	-0.0163	4.4
261	0.0275	4.2
262	0.0000	4.4
263	-0.0012	4.9
264	-0.0163	4.4
265	-0.0194	4.2
266	-0.0163	4

APPENDIX D

THE CORRELATION MATRIX

Correlation Matrix

	X1	X2	X3	X4	X5	X6	X7	X8
X1	1.0000	0.0570	0.0844	-.1112	0.0982	0.0660	-.0189	0.0664
X2	0.0570	1.0000	0.4416	-.0702	0.3299	0.0271	0.0706	-.0069
X3	0.0844	0.4416	1.0000	-.0553	0.4964	-.0737	0.0337	0.0690
X4	-.1112	-.0702	-.0553	1.0000	-.0781	-.0569	-.0443	-.0701
X5	0.0982	0.3299	0.4964	-.0781	1.0000	0.6802	-.1167	-.0779
X6	0.0660	0.0271	-.0737	-.0569	0.6802	1.0000	-.1143	-.0964
X7	-.0189	0.0706	0.0337	-.0443	-.1167	-.1143	1.0000	0.0458
X8	0.0664	-.0069	0.0690	-.0701	-.0779	-.0964	0.0458	1.0000
X9	-.0339	-.0671	-.0098	0.9093	-.0235	-.0436	-.0677	-.0400
X10	0.1818	0.0905	0.1972	0.1629	0.1680	0.0045	0.0259	0.0408
X11	-.0058	-.0286	0.0310	0.4199	0.1010	0.0256	-.0917	-.1030
X12	0.0621	0.0423	0.1017	0.1494	0.1146	0.0296	0.0236	-.0970
X13	0.1133	0.1236	0.1179	-.1159	0.2686	0.1850	0.0056	0.3176
X14	-.0287	-.1009	-.0484	-.1262	-.0265	0.0319	-.0358	-.0668
X15	0.4745	-.0392	0.1239	-.1941	0.0919	0.0446	-.0255	-.0190
X16	-.3397	0.0096	-.1180	0.1143	-.0524	-.0096	-.0458	-.0407

Correlation Matrix (Contd')

	X9	X10	X11	X12	X13	X14	X15	X16
X1	-.0339	0.1818	-.0058	0.0621	0.1133	-.0287	0.4745	-.3397
X2	-.0671	0.0905	-.0286	0.0423	0.1236	-.1009	-.0392	0.0096
X3	-.0098	0.1972	0.0310	0.1017	0.1179	-.0484	0.1239	-.1180
X4	0.9093	0.1629	0.4199	0.1494	-.1159	-.1262	-.1941	0.1143
X5	-.0235	0.1680	0.1010	0.1146	0.2686	-.0265	0.0919	-.0524
X6	-.0436	0.0045	0.0256	0.0296	0.1850	0.0319	0.0446	-.0096
X7	-.0677	0.0259	-.0917	0.0236	0.0056	-.0358	-.0255	-.0458
X8	-.0400	0.0408	-.1030	-.0970	0.3176	-.0668	-.0190	-.0407
X9	1.0000	0.4088	0.5918	0.3274	-.0748	-.0942	-.1173	0.0882
X10	0.4088	1.0000	0.4545	0.6587	0.0252	0.0248	0.2337	-.1109
X11	0.5918	0.4545	1.0000	0.5505	-.0300	-.0660	-.0603	0.0469
X12	0.3274	0.6587	0.5505	1.0000	0.0110	-.0042	0.0643	-.0917
X13	-.0748	0.0252	-.0300	0.0110	1.0000	0.0327	0.0371	0.0440
X14	-.0942	0.0248	-.0660	-.0042	0.0327	1.0000	0.5361	-.1246
X15	-.1173	0.2337	-.0603	0.0643	0.0371	0.5361	1.0000	-.3505
X16	0.0882	-.1109	0.0469	-.0917	0.0440	-.1246	-.3505	1.0000

APPENDIX E

SAS PROGRAM

```
/* ************************************************************
*                                                             *
* Predicting Construction Cost Growth in ODOT's Paving Projects *
*        using Information Available at the Bidding Time      *
*                                                             *
************************************************************* */

dm 'output; clear; log; clear;';

options ls=66 ps=44 pageno=1 nodate;

title;
title 'Predicting Cost Growth in ODOTs Paving Projects';

data a;

input id x17 $ x18 $ x1 x2 y x3 x19 $ x4 x20 $ x5 x6 x7
      x21 $ x22 $ x8 x9 x10 x11 x12 x13 x14 x15 x16;

if x20='a' then d1=1; else d1=0;
if x20='b' then d2=1; else d2=0;
if x20='c' then d3=1; else d3=0;
if x20='d' then d4=1; else d4=0;
if x20='e' then d5=1; else d5=0;
if x20='f' then d6=1; else d6=0;
if x20='g' then d7=1; else d7=0;
if x20='h' then d8=1; else d8=0;
if x20='i' then d9=1; else d9=0;
if x20='j' then d10=1; else d10=0;
if x20='k' then d11=1; else d11=0;
if x20='l' then d12=1; else d12=0;
if x20='m' then d13=1; else d13=0;
if x20='n' then d14=1; else d14=0;
if x20='o' then d15=1; else d15=0;
if x20='p' then d16=1; else d16=0;
if x20='q' then d17=1; else d17=0;
if x20='r' then d18=1; else d18=0;
if x20='s' then d19=1; else d19=0;
if x20='t' then d20=1; else d20=0;
if x20='u' then d21=1; else d21=0;
if x20='v' then d22=1; else d22=0;
if x20='w' then d23=1; else d23=0;
```

```
if x20='x' then d24=1; else d24=0;
if x20='y' then d25=1; else d25=0;
if x20='z' then d26=1; else d26=0;
if x20='ab' then d27=1; else d27=0;
if x20='ac' then d28=1; else d28=0;
if x20='ad' then d29=1; else d29=0;
if x20='ae' then d30=1; else d30=0;
if x20='af' then d31=1; else d31=0;
if x20='ag' then d32=1; else d32=0;
if x20='ah' then d33=1; else d33=0;
if x20='ai' then d34=1; else d34=0;
if x20='aj' then d35=1; else d35=0;
if x20='ak' then d36=1; else d36=0;
if x20='al' then d37=1; else d37=0;
if x20='am' then d38=1; else d38=0;
if x20='an' then d39=1; else d39=0;
if x20='ao' then d40=1; else d40=0;
if x20='ap' then d41=1; else d41=0;
if x20='aq' then d42=1; else d42=0;
if x20='ar' then d43=1; else d43=0;

if _n_=34 then delete;
if _n_=35 then delete;
if _n_=40 then delete;
if _n_=71 then delete;
if _n_=139 then delete;
if _n_=188 then delete;
if _n_=201 then delete;
if _n_=205 then delete;
if _n_=214 then delete;
if _n_=229 then delete;
if _n_=259 then delete;

/* id = project identification number */
/* x1 = number of bids */
/* x2 = contract amount */
/* x3 = duration */
/* x4 = number of projects */
/* x5 = bad weather days */
/* x6 = ratio of bad weather days */
/* x7 = bidding environment */
/* x8 = timing of notice to proceed */
/* x9 = number of projects with overrun */
```

```
/* x10 = ratio of projects with overrun */
/* x11 = average overrun */
/* x12 = average cost growth */
/* x13 = unemployment rate  */
/* x14 = MLOT ratio */
/* x15 = bid range ratio */
/* x16 = contract difference ratio */
/* x17 = location */
/* x18 = project type */
/* x19 = contractor */
/* x20 = resident engineer */
/* x21 = unit system */
/* x22 = existence of out-of-state firm */
/* y = cost growth */

cards;
1       Canadian        Resurfacing       3       149181.50       -0.043
2       Noble       Resurfacing       2       313700.00       -0.0513
3       Noble       Resurfacing       2       565917.65       0.0000
4       Nowata       Resurfacing       2       870893.75       -0.0005
5       Okfuskee       Surfacing       4       261618.90       -0.0206
6       Okfuskee       Surfacing       3       342922.15       -0.0033
7       Okfuskee       Overlay       4       131001.20       0.0035
8       Oklahoma       Resurfacing       6       425655.00       0.0000
9       Oklahoma       Resurfacing       6       42375.00       0.0441
10       Oklahoma       Resurfacing       6       136167.34       0.013
11       Oklahoma       Overlay       4       722845.00       -0.0171
12       Oklahoma       Resurfacing       2       1588096.50       0.04
13       Oklahoma       Resurfacing       3       549157.00       -0.10
14       Okmulgee       Resurfacing       3       268726.40       -0.05
15       Okmulgee       Resurfacing       3       216896.40       -0.02
16       Osage       Overlay       2       252520.00       -0.0132
17       Osage       Resurfacing       2       703436.50       -0.0118
18       Osage       Overlay       5       849444.00       -0.0103
19       Tulsa       Resurfacing       3       643280.04       -0.0711
20       McClain       Resurfacing       5       61863.20       -0.1210
21       McClain       Resurfacing       6       207588.25       0.0071
22       McCurtain       Resurfacing       2       487762.00       -0.0
23       McCurtain       Resurfacing       3       494464.00       -0.0
24       Mcintosh       Resurfacing       3       163662.00       -0.02
25       Mcintosh       Resurfacing       3       255885.00       -0.01
26       Mcintosh       Overlay       3       129900.00       -0.0048
27       Major       Overlay       1       308292.08       -0.0067
```

28	Marshall	Resurfacing	4	118123.35	-0.01
29	Mayes	Overlay	4	306246.40	-0.0046
30	Murray	Resurfacing	2	486327.65	-0.0463
31	Murray	Resurfacing	4	323778.50	-0.0219
32	Muskogee	Resurfacing	3	539665.10	0.003
33	Muskogee	Surfacing	3	169921.00	0.0163
34	Muskogee	Resurfacing	4	138112.65	0.195
35	Muskogee	Resurfacing	2	255376.00	0.232
36	Muskogee	Resurfacing	3	23163.00	-0.005
37	Muskogee	Resurfacing	3	222697.23	-0.02
38	Latimer	Resurfacing	1	156761.00	-0.002
39	Canadian	Resurfacing	4	3426952.95	0.00
40	Oklahoma	Resurfacing	2	1312190.14	-0.2
41	LeFlore	Resurfacing	2	318207.50	-0.003
42	LeFlore	Resurfacing	1	471757.90	-0.004
43	Lincoln	Resurfacing	2	122475.20	-0.025
44	Lincoln	Resurfacing	3	444213.60	-0.006
45	Lincoln	Resurfacing	4	668714.32	-0.002
46	Lincoln	Resurfacing	4	697812.95	-0.012
47	Love	Resurfacing	4	2157646.21	0.0411
48	Oklahoma	Overlay	2	575394.50	-0.0818
49	Johnson	Resurfacing	4	463362.50	-0.004
50	Johnson	Resurfacing	3	220110.12	-0.002
51	Kay	Resurfacing	4	1216269.00	-0.0274
52	Kay	Resurfacing	5	641414.50	-0.0331
53	Kingfisher	Surfacing	6	95006.70	0.0038
54	Kingfisher	Resurfacing	2	91463.65	-0.0
55	Kingfisher	Resurfacing	5	103528.75	0.0
56	Kingfisher	Resurfacing	4	314780.00	-0.
57	Grant	Resurfacing	1	53271.69	-0.0485
58	Grant	Surfacing	3	151742.00	-0.0014
59	Grant	Surfacing	3	98075.00	0.0000
60	Grant	Resurfacing	2	365640.00	0.0018
61	Rogers	Surfacing	3	389977.19	-0.0405
62	Hughes	Surfacing	4	888210.40	0.1016
63	Hughes	Resurfacing	3	411630.15	-0.0040
64	Hughes	Surfacing	3	246096.72	-0.0267
65	Jackson	Surfacing	2	1835630.78	0.0708
66	Jackson	Surfacing	2	196828.35	-0.0893
67	Creek	Resurfacing	3	693532.00	-0.1111
68	Custer	Surfacing	3	896891.10	0.0086
69	Custer	Resurfacing	4	995551.00	-0.0100
70	Delaware	Surfacing	2	843926.21	-0.1446

71	Delaware	Resurfacing	3	129097.77	-0.00
72	Delaware	Resurfacing	3	298567.84	0.001
73	Delaware	Overlay	2	80321.00	-0.0559
74	Ellis	Resurfacing	1	418066.95	-0.0098
75	Garfield	Surfacing	1	1920149.45	0.0116
76	Garfield	Resurfacing	1	187315.00	0.044
77	Garfield	Resurfacing	2	267416.00	-0.11
78	Garfield	Resurfacing	1	726491.10	-0.03
79	Garfield	Resurfacing	1	312500.00	-0.10
80	Garvin	Resurfacing	5	203020.40	-0.0535
81	Garvin	Resurfacing	3	956353.54	0.0190
82	Garvin	Resurfacing	7	514677.97	-0.0250
83	Grady	Surfacing	3	1840395.85	0.0506
84	Grady	Overlay	4	407454.60	-0.0430
85	Grady	Overlay	5	492168.40	-0.0627
86	Grady	Resurfacing	5	495026.00	-0.0324
87	Carter	Surfacing	2	99590.00	0.0000
88	Jefferson	Resurfacing	4	1259946.00	-0.
89	Carter	Resurfacing	1	468832.50	-0.0167
90	Carter	Resurfacing	1	198589.00	-0.0209
91	Cherokee	Surfacing	5	1196989.50	0.0201
92	Delaware	Overlay	7	324440.00	-0.0063
93	Cherokee	Overlay	7	322796.22	0.0517
94	Choctaw	Resurfacing	2	675361.50	-0.021
95	Cimarron	Overlay	2	523588.00	-0.0066
96	Cimarron	Overlay	2	648893.02	-0.0043
97	Cimarron	Resurfacing	1	396257.16	-0.00
98	Cleveland	Surfacing	7	288691.58	-0.031
99	Cleveland	Resurfacing	9	238088.20	0.00
100	Cleveland	Resurfacing	4	538515.30	0.1
101	Coal	Resurfacing	3	491871.80	-0.0071
102	Comanche	Resurfacing	2	18805.00	-0.07
103	Comanche	Resurfacing	1	79682.50	-0.10
104	Comanche	Overlay	2	773653.73	-0.0401
105	Craig	Resurfacing	1	42135.50	-0.0654
106	Craig	Resurfacing	1	304466.50	-0.0228
107	Craig	Resurfacing	4	362313.80	-0.0403
108	Craig	Resurfacing	1	34811.50	-0.0954
109	Craig	Resurfacing	2	465177.88	-0.0042
110	Adair	Resurfacing	3	85468.50	-0.0008
111	Adair	Resurfacing	5	1027032.50	0.0028
112	Alfalfa	Resurfacing	1	490372.80	-0.05
113	Alfalfa	Resurfacing	2	330415.45	-0.02

114	Atoka	Resurfacing	2	204245.00	0.0108
115	Beaver	Surfacing	3	2397807.06	0.0186
116	Beaver	Resurfacing	2	605787.04	0.0000
117	Beckham	Resurfacing	1	448402.00	-0.03
118	Washita	Resurfacing	3	1073466.10	-0.0
119	Beckham	Resurfacing	3	485207.00	-0.02
120	Dewey	Overlay	3	1463736.92	0.0000
121	Bryan	Surfacing	2	686789.74	0.0000
122	Bryan	Resurfacing	1	141424.37	-0.0221
123	Bryan	Resurfacing	3	168490.50	-0.0014
124	Bryan	Resurfacing	5	719882.40	-0.0080
125	Caddo	Resurfacing	5	379880.51	-0.0438
126	Canadian	Surfacing	5	821583.63	0.0260
127	Seminole	Surfacing	3	61687.00	0.0637
128	Seminole	Resurfacing	2	38815.10	-0.00
129	Seminole	Resurfacing	2	48514.35	-0.00
130	Seminole	Overlay	3	49653.20	-0.0673
131	Pushmataha	Resurfacing	2	195650.00	-0
132	Pontotoc	Resurfacing	4	442922.85	-0.0
133	Pittsburg	Resurfacing	3	409725.06	-0.
134	Pittsburg	Resurfacing	3	435327.70	-0.
135	Payne	Resurfacing	3	827312.95	0.1159
136	Payne	Resurfacing	1	278742.50	-0.0126
137	Payne	Resurfacing	3	368405.32	-0.0084
138	Payne	Resurfacing	1	221516.25	0.0679
139	Payne	Overlay	1	153340.00	-0.2974
140	Pawnee	Resurfacing	3	269925.00	0.0511
141	Ottawa	Resurfacing	2	349914.80	-0.010
142	Ottawa	Overlay	2	401876.80	-0.0202
143	Ottawa	Resurfacing	2	196261.00	-0.017
144	Woods	Surfacing	6	332323.00	-0.0276
145	Washita	Resurfacing	4	500682.25	-0.00
146	Washington	Resurfacing	2	217660.00	0.
147	Wagoner	Resurfacing	3	315197.00	-0.01
148	Wagoner	Overlay	6	220814.00	-0.0560
149	Tulsa	Resurfacing	4	1030439.70	-0.004
150	Tulsa	Surfacing	3	565601.36	0.0198
151	Tillman	Overlay	3	252324.00	0.0000
152	Texas	Resurfacing	2	937448.50	-0.0005
153	Texas	Resurfacing	2	596116.40	-0.0130
154	Stephens	Resurfacing	4	482200.00	-0.0
155	Stephens	Resurfacing	2	217969.70	-0.0
156	Stephens	Overlay	6	393896.92	-0.0081

157	Sequoyah	Resurfacing	2	39683.58	-0.00
158	Sequoyah	Resurfacing	5	84762.32	-0.02
159	Sequoyah	Resurfacing	4	76788.16	-0.02
160	Sequoyah	Resurfacing	4	134946.80	-0.0
161	Woodward	Resurfacing	2	392365.40	-0.0
162	Woodward	Resurfacing	2	599976.91	-0.0
163	Woods	Resurfacing	3	558509.80	-0.0019
164	Woods	Resurfacing	2	179871.85	-0.0126
165	Woods	Resurfacing	1	152840.50	-0.0816
166	Woods	Resurfacing	1	60843.03	-0.0874
167	Washita	Resurfacing	3	66045.00	-0.004
168	Washington	Resurfacing	2	352866.87	-0
169	Wagoner	Surfacing	5	307383.75	-0.0167
170	Wagoner	Resurfacing	5	560836.00	-0.04
171	Tulsa	Resurfacing	2	2132314.53	-0.120
172	Tulsa	Resurfacing	2	135310.00	-0.0093
173	Tillman	Resurfacing	4	198224.70	-0.06
174	Tillman	Resurfacing	3	53077.90	0.0000
175	Tillman	Resurfacing	4	391063.33	-0.02
176	Texas	Resurfacing	2	536307.80	0.0000
177	Texas	Resurfacing	1	538649.00	-0.0011
178	Sequoyah	Resurfacing	4	208650.00	-0.0
179	Sequoyah	Resurfacing	3	293000.00	-0.0
180	Seminole	Resurfacing	4	781886.46	-0.0
181	Rogers	Resurfacing	4	490537.20	0.0067
182	Rogers	Resurfacing	3	599439.40	0.0062
183	Pottawatomie	Resurfacing	3	539600.84	
184	Pontotoc	Resurfacing	3	490967.20	-0.0
185	Pittsburg	Resurfacing	3	635442.50	-0.
186	Payne	Resurfacing	1	1228850.00	-0.032
187	Payne	Resurfacing	2	429080.00	0.0122
188	Payne	Resurfacing	1	272665.00	0.1913
189	Pawnee	Resurfacing	4	511354.05	-0.031
190	Ottawa	Resurfacing	2	117837.70	-0.003
191	Ottawa	Resurfacing	3	377052.00	-0.017
192	Ottawa	Resurfacing	2	507211.25	-0.009
193	Osage	Resurfacing	1	758695.00	-0.0151
194	Osage	Resurfacing	4	597184.50	-0.0156
195	Osage	Resurfacing	5	474868.25	-0.0050
196	Okmulgee	Resurfacing	5	178764.00	-0.1
197	Okmulgee	Resurfacing	3	908167.40	-0.0
198	Oklahoma	Resurfacing	2	127535.00	-0.1
199	Okfuskee	Resurfacing	3	270211.50	0.03

200	Noble	Resurfacing	1	514894.60	0.1124
201	Noble	Resurfacing	2	533536.00	0.3301
202	Muskogee	Resurfacing	3	484900.00	-0.1
203	Muskogee	Surfacing	4	229913.30	0.0645
204	Muskogee	Resurfacing	4	25449.85	-0.01
205	Muskogee	Resurfacing	2	350430.00	-0.3
206	Murray	Resurfacing	4	272585.76	-0.110
207	Mayes	Resurfacing	5	333110.51	-0.0018
208	Mayes	Resurfacing	4	134364.00	-0.0613
209	Marshall	Resurfacing	3	41249.40	-0.00
210	Marshall	Resurfacing	4	159788.56	-0.0
211	Major	Resurfacing	1	212021.05	0.0724
212	Mcintosh	Resurfacing	3	161755.00	-0.0
213	Mcintosh	Resurfacing	3	116289.00	-0.0
214	Mcintosh	Resurfacing	2	124350.00	0.90
215	McCurtain	Resurfacing	3	509683.50	-0.
216	McCurtain	Resurfacing	2	297962.56	-0.
217	McCurtain	Resurfacing	2	319543.84	0.0
218	McClain	Resurfacing	4	559525.00	-0.00
219	McClain	Resurfacing	4	203302.46	-0.02
220	McClain	Resurfacing	6	722514.07	-0.00
221	Logan	Resurfacing	3	295500.00	-0.0061
222	Kay	Resurfacing	5	945665.00	-0.0178
223	Kay	Surfacing	2	44277.00	-0.0533
224	Johnson	Resurfacing	3	560823.00	0.011
225	Johnson	Resurfacing	5	277081.84	-0.01
226	Jackson	Resurfacing	4	390522.90	-0.01
227	Hughes	Surfacing	3	46354.40	0.0414
228	Haskell	Resurfacing	3	496655.00	-0.02
229	Harper	Resurfacing	1	90765.40	0.1698
230	Greer	Resurfacing	7	667175.20	0.0848
231	Grant	Resurfacing	1	239080.00	-0.1290
232	Grady	Resurfacing	3	84694.40	0.1211
233	Garfield	Resurfacing	1	463065.00	-0.0
234	Ellis	Resurfacing	2	314860.75	-0.0002
235	Delaware	Resurfacing	4	862339.95	-0.0
236	Custer	Resurfacing	3	116767.60	-0.030
237	Custer	Resurfacing	2	1176889.53	0.020
238	Creek	Resurfacing	1	319285.90	-0.0267
239	Creek	Resurfacing	1	176597.30	-0.0638
240	Creek	Resurfacing	1	294266.10	-0.0589
241	Coal	Resurfacing	3	598378.50	-0.0152
242	Coal	Resurfacing	3	789329.77	-0.0154

```
243      Coal      Resurfacing      2      82631.93      0.0130
244      Cimarron     Resurfacing      1      265585.50      -0.0
245      Cherokee     Resurfacing      4      60028.90      -0.01
246      Cherokee     Resurfacing      4      301977.75      -0.0
247      Carter     Resurfacing      2      31483.85      -0.1298
248      Carter     Resurfacing      2      179860.38      -0.036
249      Canadian     Resurfacing      2      141540.00      0.06
250      Canadian     Resurfacing      2      339415.00      -0.0
251      Caddo     Resurfacing      3      416637.41      -0.0711
252      LeFlore     Overlay      1      321756.95      -0.0031
253      LeFlore     Overlay      1      350524.41      -0.0013
254      LeFlore     Overlay      1      203939.55      -0.0026
255      LeFlore     Overlay      1      366892.80      -0.0004
256      LeFlore     Overlay      1      358927.80      0.0000
257      Caddo     Resurfacing      3      178101.84      -0.0125
258      Blaine     Resurfacing      4      207770.00      0.0002
259      Blaine     Resurfacing      2      75985.00      0.1725
260      Blaine     Resurfacing      3      491838.65      0.0109
261      Beckham     Resurfacing      6      372802.98      -0.03
262      Beckham     Resurfacing      1      372275.12      -0.00
263      Beaver     Resurfacing      2      719863.10      -0.001
264      Atoka     Resurfacing      5      197749.65      -0.0655
265      Alfalfa     Resurfacing      4      293030.08      -0.00
266      Alfalfa     Resurfacing      1      211626.15      0.000

proc princomp out=one data=a;
var x1 x2 x3 x4 x5 x6 x7 x8 x9 x10 x11 x12 x13 x14 x15 x16;

proc plot data=one;
plot prin2*prin1=prin3 / contour=10;

proc factor data=a rotate=varimax nfact=8 scree out=b;
var x1-x16;

data combined;
merge a b;

proc glm data=combined;
classes x17 x18 x19 x20 x21 x22;
model y=factor1 factor2 factor3 factor4 factor5 factor6
       factor7 factor8 x17 x18 x19 x20 x21 x22;

proc glm data=combined;
```

```
classes x17 x18 x19 x20 x21 x22;
model y=factor1 factor4 factor5 x20;

proc reg data=combined;
model y=factor1 factor4 factor5 d1 d2 d3 d4 d5 d6 d7 d8 d9
        d10 d11 d12 d13 d14 d15 d16 d17 d18 d19 d20 d21 d22
        d23 d24 d25 d26 d27 d28 d29 d30 d31 d32 d33 d34 d35
        d36 d37 d38 d39 d40 d41 d42 d43;

run;
```

APPENDIX F

SAS OUTPUT

Principal Component Analysis

255 Observations
16 Variables

Simple Statistics

	X1	X2	X3	X4
Mean	2.996078431	445694.5272	132.3490196	14.67843137
StD	1.486151398	421696.3384	110.1611550	11.46436303

	X5	X6	X7	X8
Mean	21.67058824	0.1842745098	13.87450980	38.61176471
StD	29.65061175	0.3061806938	8.37130088	15.90084491

	X9	X10	X11	X12
Mean	3.564705882	0.2164705882	4.324627451	-.0113725490
StD	4.053132527	0.2097807585	4.826807906	0.0257654172

	X13	X14	X15	X16
Mean	4.432941176	0.0830388235	0.1887062745	-.0190717647
StD	0.475060270	0.1089492984	0.2014787448	0.1422478540

Principal Component Analysis

Correlation Matrix

	X1	X2	X3	X4	X5	X6
X1	1.0000	0.0450	0.0794	-.1209	0.0848	0.0534
X2	0.0450	1.0000	0.4555	-.0640	0.3367	0.0222
X3	0.0794	0.4555	1.0000	-.0893	0.4848	-.0801
X4	-.1209	-.0640	-.0893	1.0000	-.1003	-.0572
X5	0.0848	0.3367	0.4848	-.1003	1.0000	0.6825
X6	0.0534	0.0222	-.0801	-.0572	0.6825	1.0000
X7	-.0127	0.0699	0.0255	-.0560	-.1185	-.1122
X8	0.0736	0.0004	0.0746	-.0695	-.0811	-.0978
X9	-.0304	-.0527	-.0424	0.9081	-.0405	-.0394
X10	0.2227	0.1193	0.2117	0.1773	0.1867	0.0177
X11	0.0391	0.0021	0.0284	0.4334	0.1235	0.0518
X12	0.1202	0.0837	0.1238	0.1839	0.1509	0.0559
X13	0.1022	0.1201	0.1302	-.1068	0.2738	0.1785
X14	-.0258	-.0997	-.0587	-.1452	-.0263	0.0335
X15	0.4730	-.0448	0.1214	-.2054	0.0876	0.0386
X16	-.3549	0.0164	-.1129	0.1360	-.0591	-.0175

	X7	X8	X9	X10	X11	X12
X1	-.0127	0.0736	-.0304	0.2227	0.0391	0.1202
X2	0.0699	0.0004	-.0527	0.1193	0.0021	0.0837
X3	0.0255	0.0746	-.0424	0.2117	0.0284	0.1238
X4	-.0560	-.0695	0.9081	0.1773	0.4334	0.1839
X5	-.1185	-.0811	-.0405	0.1867	0.1235	0.1509
X6	-.1122	-.0978	-.0394	0.0177	0.0518	0.0559
X7	1.0000	0.0396	-.0796	0.0360	-.1048	0.0405
X8	0.0396	1.0000	-.0398	0.0449	-.1242	-.0998
X9	-.0796	-.0398	1.0000	0.4230	0.5969	0.3588
X10	0.0360	0.0449	0.4230	1.0000	0.4278	0.6309
X11	-.1048	-.1242	0.5969	0.4278	1.0000	0.5276
X12	0.0405	-.0998	0.3588	0.6309	0.5276	1.0000
X13	0.0138	0.3109	-.0592	0.0501	0.0026	0.0561
X14	-.0301	-.0505	-.1189	0.0208	-.0766	-.0120
X15	-.0197	-.0083	-.1236	0.2576	-.0397	0.0952
X16	-.0404	-.0650	0.1110	-.1232	0.0654	-.1075

Principal Component Analysis

Correlation Matrix

	X13	X14	X15	X16
X1	0.1022	-.0258	0.4730	-.3549
X2	0.1201	-.0997	-.0448	0.0164
X3	0.1302	-.0587	0.1214	-.1129
X4	-.1068	-.1452	-.2054	0.1360
X5	0.2738	-.0263	0.0876	-.0591
X6	0.1785	0.0335	0.0386	-.0175
X7	0.0138	-.0301	-.0197	-.0404
X8	0.3109	-.0505	-.0083	-.0650
X9	-.0592	-.1189	-.1236	0.1110
X10	0.0501	0.0208	0.2576	-.1232
X11	0.0026	-.0766	-.0397	0.0654
X12	0.0561	-.0120	0.0952	-.1075
X13	1.0000	0.0324	0.0296	0.0247
X14	0.0324	1.0000	0.5332	-.1165
X15	0.0296	0.5332	1.0000	-.3571
X16	0.0247	-.1165	-.3571	1.0000

Principal Component Analysis

Eigenvalues of the Correlation Matrix

	Eigenvalue	Difference	Proportion	Cumulative
PRIN1	2.95192	0.411360	0.184495	0.18450
PRIN2	2.54056	0.647996	0.158785	0.34328
PRIN3	1.89256	0.415849	0.118285	0.46157
PRIN4	1.47672	0.238840	0.092295	0.55386
PRIN5	1.23788	0.194781	0.077367	0.63123
PRIN6	1.04309	0.049113	0.065193	0.69642
PRIN7	0.99398	0.147653	0.062124	0.75854
PRIN8	0.84633	0.139435	0.052895	0.81144
PRIN9	0.70689	0.110006	0.044181	0.85562
PRIN10	0.59689	0.048227	0.037305	0.89293
PRIN11	0.54866	0.103186	0.034291	0.92722
PRIN12	0.44547	0.134873	0.027842	0.95506
PRIN13	0.31060	0.064590	0.019413	0.97447
PRIN14	0.24601	0.131343	0.015376	0.98985
PRIN15	0.11467	0.066897	0.007167	0.99701
PRIN16	0.04777	.	0.002986	1.00000

Principal Component Analysis

Eigenvectors

	PRIN1	PRIN2	PRIN3	PRIN4	PRIN5	PRIN6
X1	0.056826	0.318674	-.285201	0.081309	0.137965	-.495270
X2	0.067830	0.235451	0.335810	0.310093	-.292900	0.101180
X3	0.096188	0.330002	0.245373	0.339276	-.253302	0.121283
X4	0.398864	-.303594	-.003775	-.027272	0.096290	-.003345
X5	0.134888	0.404963	0.410763	-.261959	-.029507	-.031967
X6	0.057073	0.237911	0.281905	-.557273	0.164459	-.145964
X7	-.048540	0.002282	-.045285	0.358019	-.121465	0.119405
X8	-.065224	0.065524	0.007594	0.378947	0.639673	0.076235
X9	0.490947	-.222781	-.050098	-.009589	0.118904	0.022978
X10	0.406299	0.206417	-.155387	0.141638	-.015662	0.085916
X11	0.462080	-.047222	-.023654	-.081854	0.005670	0.026549
X12	0.410732	0.138599	-.101740	0.055602	-.089131	0.060158
X13	0.011768	0.227739	0.202543	0.085440	0.587403	0.242760
X14	-.084111	0.169559	-.341109	-.273598	-.035709	0.659260
X15	-.007796	0.377117	-.450166	-.113853	-.029465	0.160680
X16	0.012778	-.283780	0.312684	-.073219	0.018527	0.394645

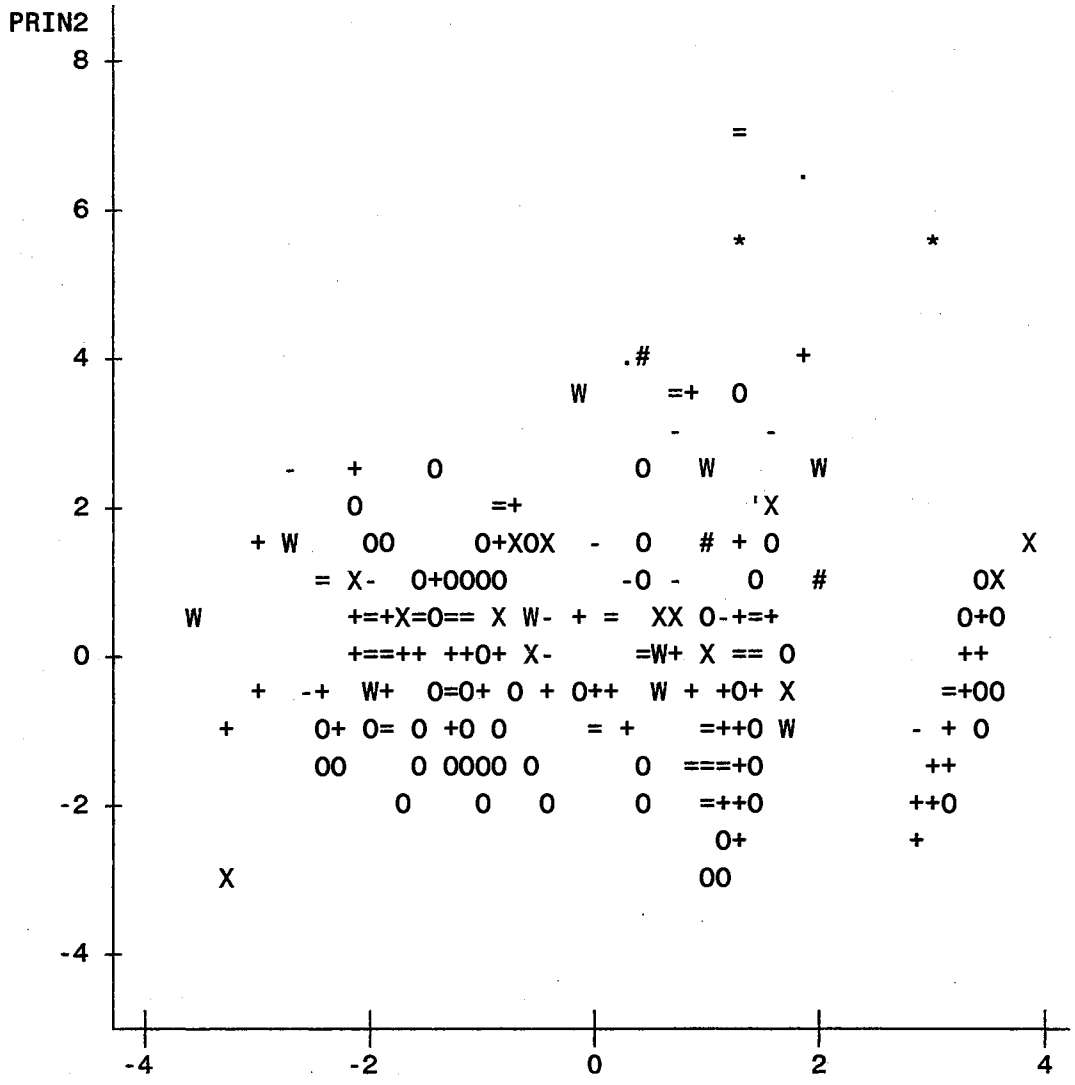
	PRIN7	PRIN8	PRIN9	PRIN10	PRIN11	PRIN12
X1	-.073833	0.042686	0.555706	0.085862	-.038640	0.095685
X2	-.177240	0.112723	0.263725	-.112735	0.700735	0.063097
X3	-.329815	0.060309	-.173882	0.048538	-.527599	0.040761
X4	-.233492	0.469069	0.025646	-.039257	0.002294	-.158848
X5	-.007165	0.134937	-.116326	0.118194	-.163526	0.035838
X6	0.245137	0.205858	-.077902	0.211735	0.180387	0.024521
X7	0.711538	0.528518	0.075036	0.074199	-.134766	0.146284
X8	-.115864	-.011236	-.310862	0.417986	0.208654	0.278130
X9	-.172252	0.299252	0.028521	0.028132	0.000958	-.117891
X10	0.156841	-.227172	-.078093	0.340952	0.073766	-.412003
X11	0.050808	-.195695	0.046996	-.187773	-.082266	0.770502
X12	0.342325	-.376674	-.139256	-.128789	0.113981	-.120279
X13	0.104641	-.032636	0.250280	-.567090	-.154164	-.230834
X14	-.105397	0.154471	-.058232	-.071101	0.152969	0.119021
X15	-.148770	0.122682	0.194420	0.166367	-.102319	0.002442
X16	0.041900	-.245863	0.580120	0.462378	-.159046	0.009253

Principal Component Analysis

Eigenvectors

	PRIN13	PRIN14	PRIN15	PRIN16
X1	0.236579	0.389520	-.017158	0.029110
X2	-.057891	-.094443	0.032451	-.017107
X3	0.168731	0.089896	0.407517	0.002936
X4	0.175781	-.085388	-.044869	0.629693
X5	-.012925	0.050839	-.708357	-.016140
X6	0.062901	-.038011	0.556605	0.006582
X7	-.022358	0.009974	-.033309	-.019390
X8	0.141629	-.054077	-.061843	0.014204
X9	-.006363	0.039670	0.007152	-.745439
X10	-.519134	0.247149	0.059743	0.180520
X11	-.286584	-.020647	0.058552	0.107164
X12	0.656044	-.176959	-.051699	-.014003
X13	-.127726	-.044803	0.062607	0.012664
X14	0.162831	0.478428	-.014199	0.021762
X15	-.104065	-.700432	-.014190	-.025564
X16	0.144592	-.032043	-.003455	0.014896

Contour plot of PRIN2*PRIN1.



Symbol	PRIN3	Symbol	PRIN3	Symbol	PRIN3
.....	-5 - -4	+++++	-1 - 0	*****	3 - 4
'''''	-4 - -3	00000	0 - 1	#####	4 - 5
-----	-3 - -2	XXXXX	1 - 2		
=====	-2 - -1	WWWWW	2 - 3		

NOTE: 80 obs hidden.

Initial Factor Method: Principal Components

Prior Communality Estimates: ONE

Eigenvalues of the Correlation Matrix: Total = 16 Average = 1

	1	2	3	4
Eigenvalue	2.9519	2.5406	1.8926	1.4767
Difference	0.4114	0.6480	0.4158	0.2388
Proportion	0.1845	0.1588	0.1183	0.0923
Cumulative	0.1845	0.3433	0.4616	0.5539

	5	6	7	8
Eigenvalue	1.2379	1.0431	0.9940	0.8463
Difference	0.1948	0.0491	0.1477	0.1394
Proportion	0.0774	0.0652	0.0621	0.0529
Cumulative	0.6312	0.6964	0.7585	0.8114

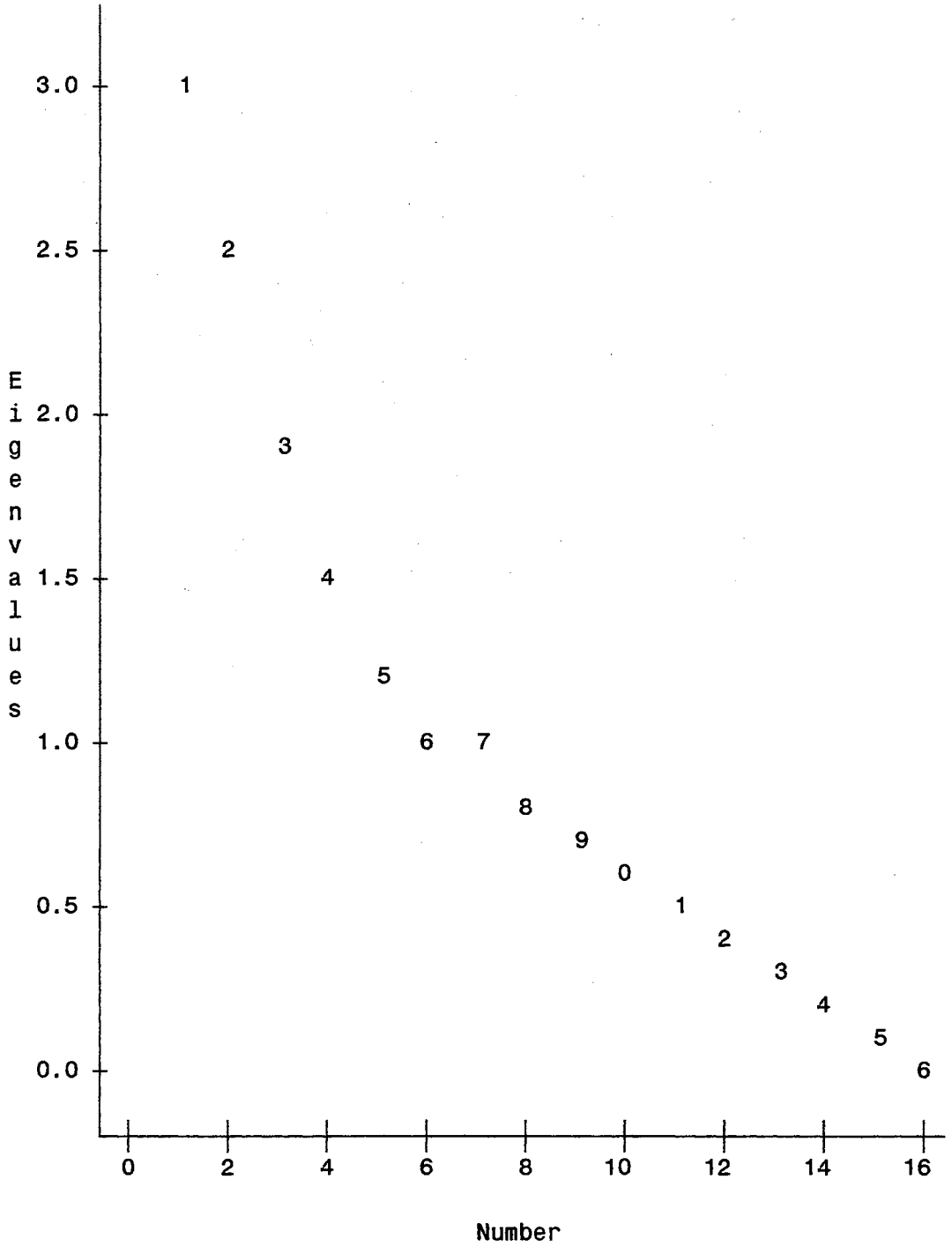
	9	10	11	12
Eigenvalue	0.7069	0.5969	0.5487	0.4455
Difference	0.1100	0.0482	0.1032	0.1349
Proportion	0.0442	0.0373	0.0343	0.0278
Cumulative	0.8556	0.8929	0.9272	0.9551

	13	14	15	16
Eigenvalue	0.3106	0.2460	0.1147	0.0478
Difference	0.0646	0.1313	0.0669	
Proportion	0.0194	0.0154	0.0072	0.0030
Cumulative	0.9745	0.9898	0.9970	1.0000

8 factors will be retained by the NFACTOR criterion.

Initial Factor Method: Principal Components

Scree Plot of Eigenvalues



Initial Factor Method: Principal Components

Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
X1	0.09763	0.50794	-0.39235	0.09881
X2	0.11654	0.37529	0.46198	0.37683
X3	0.16526	0.52599	0.33756	0.41229
X4	0.68529	-0.48390	-0.00519	-0.03314
X5	0.23175	0.64548	0.56509	-0.31833
X6	0.09806	0.37921	0.38782	-0.67720
X7	-0.08340	0.00364	-0.06230	0.43507
X8	-0.11206	0.10444	0.01045	0.46050
X9	0.84350	-0.35509	-0.06892	-0.01165
X10	0.69807	0.32901	-0.21377	0.17212
X11	0.79391	-0.07527	-0.03254	-0.09947
X12	0.70568	0.22091	-0.13996	0.06757
X13	0.02022	0.36300	0.27864	0.10383
X14	-0.14451	0.27026	-0.46927	-0.33248
X15	-0.01339	0.60109	-0.61930	-0.13835
X16	0.02195	-0.45232	0.43016	-0.08898

Initial Factor Method: Principal Components

Factor Pattern

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
X1	0.15350	-0.50583	-0.07361	0.03927
X2	-0.32588	0.10334	-0.17671	0.10370
X3	-0.28182	0.12387	-0.32882	0.05548
X4	0.10713	-0.00342	-0.23279	0.43153
X5	-0.03283	-0.03265	-0.00714	0.12414
X6	0.18298	-0.14908	0.24440	0.18938
X7	-0.13514	0.12195	0.70939	0.48622
X8	0.71170	0.07786	-0.11551	-0.01034
X9	0.13229	0.02347	-0.17173	0.27530
X10	-0.01743	0.08775	0.15637	-0.20899
X11	0.00631	0.02711	0.05065	-0.18003
X12	-0.09917	0.06144	0.34129	-0.34653
X13	0.65354	0.24794	0.10433	-0.03002
X14	-0.03973	0.67332	-0.10508	0.14211
X15	-0.03278	0.16411	-0.14832	0.11286
X16	0.02061	0.40306	0.04177	-0.22618

Variance explained by each factor

FACTOR1	FACTOR2	FACTOR3	FACTOR4
2.951921	2.540561	1.892564	1.476715

FACTOR5	FACTOR6	FACTOR7	FACTOR8
1.237875	1.043094	0.993981	0.846328

Initial Factor Method: Principal Components

Final Communality Estimates: Total = 12.983040

X1	X2	X3	X4	X5	X6
0.717622	0.668697	0.793881	0.956809	0.908616	0.913718

X7	X8	X9	X10	X11	X12
0.972911	0.761661	0.965810	0.746999	0.682658	0.821119

X13	X14	X15	X16
0.720972	0.910845	0.826901	0.613818

Rotation Method: Varimax

Orthogonal Transformation Matrix

	1	2	3	4
1	0.72997	0.64875	0.12671	0.13368
2	0.21309	-0.39076	0.42430	0.46422
3	-0.16824	-0.03146	0.48169	0.45781
4	0.07703	-0.03809	-0.65552	0.45948
5	-0.06362	0.15669	0.13859	-0.40304
6	0.10961	0.00279	-0.11862	0.16238
7	0.35651	-0.31314	0.23637	-0.37393
8	-0.49430	0.54897	0.23028	0.13150

	5	6	7	8
1	0.02827	-0.07722	-0.03825	-0.06416
2	0.50966	0.32218	0.20676	-0.00812
3	-0.51714	-0.49112	0.13582	-0.04485
4	0.11764	-0.29796	0.35050	0.35540
5	0.07653	-0.05518	0.87452	-0.12676
6	-0.62386	0.70296	0.21862	0.12806
7	-0.12190	-0.16322	-0.02114	0.73294
8	0.21969	0.19084	-0.03829	0.54573

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
X1	0.14226	-0.05931	0.04705	0.00331
X2	0.03415	-0.03844	0.07420	0.80227
X3	0.09454	-0.03504	0.01776	0.87420
X4	0.09196	0.96167	-0.03967	-0.05058
X5	0.12173	-0.04238	0.81033	0.46998
X6	0.00052	-0.01528	0.94847	-0.10891
X7	0.01842	-0.04619	-0.07778	0.03487
X8	-0.09865	0.01085	-0.20700	0.01751
X9	0.34761	0.91430	-0.03099	-0.03808
X10	0.79868	0.15830	-0.01173	0.16259
X11	0.67092	0.43564	0.08636	-0.03017
X12	0.89696	0.06085	0.05128	0.04061
X13	0.09086	-0.08751	0.30165	0.08038
X14	-0.02594	-0.06537	0.01078	-0.07814
X15	0.12325	-0.11510	0.01265	0.04032
X16	0.00998	0.04795	-0.01077	-0.03921

Rotation Method: Varimax

Rotated Factor Pattern

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
X1	0.82107	-0.02518	0.10634	-0.07443
X2	-0.04510	-0.08800	0.00533	0.08430
X3	0.10011	0.03495	0.07824	-0.04263
X4	-0.09496	-0.08436	-0.05725	-0.00073
X5	0.05185	0.01110	0.04932	-0.09610
X6	0.03464	0.00727	0.00498	-0.02725
X7	0.01681	-0.02124	0.02283	0.98077
X8	0.11654	-0.06769	0.83096	-0.00102
X9	-0.04596	-0.05245	-0.00522	-0.04168
X10	0.19716	0.10304	0.08126	0.03730
X11	-0.07295	-0.06385	-0.06795	-0.14267
X12	0.04922	-0.00789	-0.04388	0.06470
X13	-0.07028	0.06308	0.77320	0.02915
X14	-0.04184	0.94754	-0.00962	0.00176
X15	0.54795	0.70298	-0.00179	-0.04737
X16	-0.76748	-0.09996	0.04680	-0.09246

Variance explained by each factor

FACTOR1	FACTOR2	FACTOR3	FACTOR4
2.101303	2.017275	1.717327	1.690859

FACTOR5	FACTOR6	FACTOR7	FACTOR8
1.657682	1.445420	1.327499	1.025676

Rotation Method: Varimax

Final Communality Estimates: Total = 12.983040

X1	X2	X3	X4	X5	X6
0.717622	0.668697	0.793881	0.956809	0.908616	0.913718

X7	X8	X9	X10	X11	X12
0.972911	0.761661	0.965810	0.746999	0.682658	0.821119

X13	X14	X15	X16
0.720972	0.910845	0.826901	0.613818

Scoring Coefficients Estimated by Regression

Squared Multiple Correlations of the Variables with each Factor

FACTOR1	FACTOR2	FACTOR3	FACTOR4
1.000000	1.000000	1.000000	1.000000

FACTOR5	FACTOR6	FACTOR7	FACTOR8
1.000000	1.000000	1.000000	1.000000

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR1	FACTOR2	FACTOR3	FACTOR4
X1	-0.00360	0.01405	0.01319	-0.06186
X2	-0.05746	0.03245	-0.04406	0.50763
X3	-0.04636	0.04341	-0.11090	0.55690
X4	-0.21379	0.59278	0.03643	0.05025
X5	-0.03220	0.02900	0.43500	0.19366
X6	-0.06176	0.04286	0.61395	-0.18847
X7	-0.00187	0.04605	0.06003	-0.01115
X8	-0.05965	0.06724	-0.14858	-0.01793
X9	-0.04240	0.49093	0.01074	0.02098
X10	0.41646	-0.08487	-0.07751	0.02161
X11	0.31356	0.05730	0.01806	-0.06148
X12	0.54536	-0.22299	-0.02965	-0.08089
X13	0.06351	-0.02765	0.14794	-0.05115
X14	-0.03659	0.06510	-0.00025	0.00523
X15	-0.00525	0.03469	-0.02329	0.02592
X16	0.11299	-0.08665	-0.02076	-0.00011

Rotation Method: Varimax

Standardized Scoring Coefficients

	FACTOR5	FACTOR6	FACTOR7	FACTOR8
X1	0.54915	-0.18305	0.03758	-0.07745
X2	-0.05317	-0.01481	-0.05787	0.05864
X3	0.01093	0.05414	-0.00591	-0.07667
X4	0.05750	0.05720	0.00390	0.07401
X5	0.00254	0.00201	-0.02097	-0.02297
X6	0.03675	-0.02452	-0.01906	0.08978
X7	0.00953	0.01238	-0.00683	0.97341
X8	0.06263	-0.04207	0.64204	-0.04248
X9	0.04141	0.05334	0.04203	0.02185
X10	0.01783	0.03131	0.05545	0.02336
X11	-0.07530	-0.03272	-0.02515	-0.11624
X12	-0.07998	-0.05611	-0.03393	0.04945
X13	-0.12332	0.06630	0.58673	0.03787
X14	-0.20081	0.73174	0.02013	0.03426
X15	0.22597	0.42706	-0.01891	-0.03334
X16	-0.51878	0.06124	0.08104	-0.09831

General Linear Models Procedure
Class Level Information

Class	Levels	Values
X17	72	Adair Alfalfa Atoka Beaver Beckham Blaine Bryan Caddo Canadian Carter Cherokee Choctaw Cimarron Clevelan Coal Comanche Craig Creek Custer Delaware Dewey Ellis Garfield Garvin Grady Grant Greer Haskell Hughes Jackson Jefferso Johnson Kay Kingfish Latimer LeFlore Lincoln Logan Love Major Marshall Mayes McClain McCurtai Mcintosh Murray Muskogee Noble Nowata Okfuskee Oklahoma Okmulgee Osage Ottawa Pawnee Payne Pittsbur Pontotoc Pottawat Pushmata Rogers Seminole Sequoyah Stephens Texas Tillman Tulsa Wagoner Washingt Washita Woods Woodward
X18	3	Overlay Resurfac Surfacin
X19	48	a ab ac ad ae af ag ah ai aj ak al am an ao ap aq ar as at au av aw ax b c d f g h i j k l m n o p q r s t u v w x y z
X20	44	a ab ac ad ae af ag ah ai aj ak al am an ao ap aq ar as b c d e f g h i j k l m n o p q r s t u v w x y z
X21	2	English EnglishM
X22	2	FALSE TRUE

Number of observations in data set = 255

General Linear Models Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	F Value	Pr > F
Model	159	0.31321238	1.40	0.0370
Error	95	0.13365632		
Corrected Total	254	0.44686871		

R-Square	C.V.	Y Mean
0.700905	-237.2325	-0.01581098

Source	DF	Type I SS	F Value	Pr > F
FACTOR1	1	0.05753182	40.89	0.0001
FACTOR2	1	0.00028285	0.20	0.6549
FACTOR3	1	0.00000449	0.00	0.9551
FACTOR4	1	0.01378888	9.80	0.0023
FACTOR5	1	0.00425945	3.03	0.0851
FACTOR6	1	0.00000584	0.00	0.9487
FACTOR7	1	0.00193581	1.38	0.2437
FACTOR8	1	0.00041728	0.30	0.5873
X17	71	0.12063844	1.21	0.1943
X18	2	0.00111905	0.40	0.6730
X19	46	0.04901517	0.76	0.8512
X20	30	0.06240888	1.48	0.0795
X21	1	0.00000362	0.00	0.9597
X22	1	0.00180080	1.28	0.2608

Source	DF	Type III SS	F Value	Pr > F
FACTOR1	1	0.00000013	0.00	0.9922
FACTOR2	1	0.00000932	0.01	0.9353
FACTOR3	1	0.00063776	0.45	0.5024
FACTOR4	1	0.00492327	3.50	0.0645
FACTOR5	1	0.00002707	0.02	0.8900

General Linear Models Procedure

Dependent Variable: Y

Source	DF	Type III SS	F Value	Pr > F
FACTOR6	1	0.00000560	0.00	0.9498
FACTOR7	1	0.00000002	0.00	0.9968
FACTOR8	1	0.00007128	0.05	0.8224
X17	58	0.06924514	0.85	0.7487
X18	2	0.00555325	1.97	0.1446
X19	45	0.05230091	0.83	0.7594
X20	30	0.06386979	1.51	0.0679
X21	1	0.00000632	0.00	0.9467
X22	1	0.00180080	1.28	0.2608

General Linear Models Procedure
Class Level Information

Class	Levels	Values
X17	72	Adair Alfalfa Atoka Beaver Beckham Blaine Bryan Caddo Canadian Carter Cherokee Choctaw Cimarron Clevelan Coal Comanche Craig Creek Custer Delaware Dewey Ellis Garfield Garvin Grady Grant Greer Haskell Hughes Jackson Jefferso Johnson Kay Kingfish Latimer LeFlore Lincoln Logan Love Major Marshall Mayes McClain McCurtai Mcintosh Murray Muskogee Noble Nowata Okfuskee Oklahoma Okmulgee Osage Ottawa Pawnee Payne Pittsbur Pontotoc Pottawat Pushmata Rogers Seminole Sequoyah Stephens Texas Tillman Tulsa Wagoner Washingt Washita Woods Woodward
X18	3	Overlay Resurfac Surfacin
X19	48	a ab ac ad ae af ag ah ai aj ak al am an ao ap aq ar as at au av aw ax b c d f g h i j k l m n o p q r s t u v w x y z
X20	44	a ab ac ad ae af ag ah ai aj ak al am an ao ap aq ar as b c d e f g h i j k l m n o p q r s t u v w x y z
X21	2	English EnglishM
X22	2	FALSE TRUE

Number of observations in data set = 255

General Linear Models Procedure

Dependent Variable: Y

Source	DF	Sum of Squares	F Value	Pr > F
Model	46	0.17513113	2.91	0.0001
Error	208	0.27173758		
Corrected Total	254	0.44686871		

R-Square	C.V.	Y Mean
0.391907	-228.6043	-0.01581098

Source	DF	Type I SS	F Value	Pr > F
FACTOR1	1	0.05753182	44.04	0.0001
FACTOR4	1	0.01378888	10.55	0.0014
FACTOR5	1	0.00425945	3.26	0.0724
X20	43	0.09955098	1.77	0.0045

Source	DF	Type III SS	F Value	Pr > F
FACTOR1	1	0.04634461	35.47	0.0001
FACTOR4	1	0.02410857	18.45	0.0001
FACTOR5	1	0.00289323	2.21	0.1382
X20	43	0.09955098	1.77	0.0045

Model: MODEL1
Dependent Variable: Y

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Prob>F
Model	46	0.17513	0.00381	2.914	0.0001
Error	208	0.27174	0.00131		
C Total	254	0.44687			

Root MSE	0.03614	R-square	0.3919
Dep Mean	-0.01581	Adj R-sq	0.2574
C.V.	-228.60429		

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0
INTERCEP	1	-0.021884	0.01635636	-1.338
FACTOR1	1	0.016076	0.00269917	5.956
FACTOR4	1	0.011505	0.00267824	4.296
FACTOR5	1	0.004255	0.00285926	1.488
D1	1	0.044729	0.04111842	1.088
D2	1	0.000822	0.01923396	0.043
D3	1	0.004939	0.02210944	0.223
D4	1	-0.003938	0.02335150	-0.169
D5	1	-0.000225	0.02792194	-0.008
D6	1	0.058595	0.03060656	1.914
D7	1	-0.034200	0.02249098	-1.521
D8	1	0.027047	0.02085936	1.297
D9	1	-0.012897	0.02040902	-0.632
D10	1	0.027271	0.02312012	1.180
D11	1	0.015430	0.02663478	0.579
D12	1	0.025768	0.01918347	1.343
D13	1	-0.001298	0.02144332	-0.061
D14	1	0.053369	0.03028749	1.762
D15	1	-0.036057	0.02457192	-1.467
D16	1	0.018909	0.02032278	0.930
D17	1	-0.037976	0.02673819	-1.420
D18	1	0.001535	0.02652006	0.058
D19	1	0.034770	0.03976844	0.874
D20	1	-0.019107	0.03066193	-0.623
D21	1	0.031827	0.02213363	1.438
D22	1	-0.111702	0.03972848	-2.812
D23	1	-0.011804	0.02211216	-0.534
D24	1	0.003557	0.03040019	0.117
D25	1	0.014693	0.02129474	0.690
D26	1	0.042427	0.02155080	1.969
D27	1	0.027879	0.03966828	0.703
D28	1	-0.008194	0.03133662	-0.261
D29	1	-0.008718	0.02134196	-0.408
D30	1	-0.010547	0.01911444	-0.552
D31	1	0.040807	0.03965707	1.029
D32	1	0.027544	0.02124506	1.297
D33	1	0.002549	0.02293659	0.111

Variable	DF	Parameter Estimate	Standard Error	T for H0: Parameter=0
D34	1	0.018827	0.02019526	0.932
D35	1	-0.004841	0.01994832	-0.243
D36	1	0.014308	0.02437254	0.587
D37	1	0.044036	0.03997889	1.101
D38	1	-0.000863	0.01801838	-0.048
D39	1	0.009202	0.02305219	0.399
D40	1	0.004821	0.02221163	0.217
D41	1	0.037630	0.02434978	1.545
D42	1	0.003495	0.01930866	0.181
D43	1	-0.006613	0.04236188	-0.156

Variable	DF	Prob > |T|
INTERCEP	1	0.1824
FACTOR1	1	0.0001
FACTOR4	1	0.0001
FACTOR5	1	0.1382
D1	1	0.2779
D2	1	0.9659
D3	1	0.8235
D4	1	0.8663
D5	1	0.9936
D6	1	0.0569
D7	1	0.1299
D8	1	0.1962
D9	1	0.5281
D10	1	0.2395
D11	1	0.5630
D12	1	0.1807
D13	1	0.9518
D14	1	0.0795
D15	1	0.1438
D16	1	0.3532
D17	1	0.1570
D18	1	0.9539
D19	1	0.3830
D20	1	0.5339
D21	1	0.1520

Variable	DF	Prob > |T|
D22	1	0.0054
D23	1	0.5940
D24	1	0.9070
D25	1	0.4910
D26	1	0.0503
D27	1	0.4830
D28	1	0.7940
D29	1	0.6833
D30	1	0.5817
D31	1	0.3047
D32	1	0.1962
D33	1	0.9116
D34	1	0.3523
D35	1	0.8085
D36	1	0.5578
D37	1	0.2720
D38	1	0.9618
D39	1	0.6902
D40	1	0.8284
D41	1	0.1238
D42	1	0.8565
D43	1	0.8761

VITA

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Doctor of Philosophy

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