DBE CAPACITY IN TEXAS HIGHWAY CONSTRUCTION INDUSTRY

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DBE CAPACITY IN TEXAS HIGHWAY CONSTRUCTION INDUSTRY

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Disclaimer

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Abstract

A method for predicting the annual highway work capacity of Disadvantaged Business Firms (DBE) , both individually and collectively, is presented. This method takes into account variables that are used to predict small business failure, and also employs different capacity estimation procedures.

Table of Contents

List of Tables

List of Figures

DBE CAPACITY IN TEXAS HIGHWAY CONSTRUCTION INDUSTRY

EXECUTIVE SUMMARY

The Surface Transportation Act of 1982 and the amendments in 1987 specified that at least ten (10) percent of of all amounts of funds authorized for transportation under this act shall be expended with small business concerns which are owned and managed by socially and economically disadvantaged persons. This includes two categories of firms, Disadvantaged Business Enterprises (DBE's) and Women Business Enterprises (WBE's). The ten percent goal can be met by the combined efforts of both groups, and the programs are referred to as "DBE programs."

All state transportation agencies have had to establish their own DBE programs to comply with the S.T.A.A. requirements. A major difficulty for most agencies, Texas included, is the ability to accurately assess the true capability of minority firms in their state to perform highway construction work. The basic objective of this study was to develop an analytical procedure for the Texas State Department of Highways and Public Transportation (SDHPT) to define and assess the capacity of the DBE firms in Texas.

The major findings and recommendations of the study are summarized below:

FINDINGS:

1. Texas is in compliance with the DBE requirements of the Surface Transportation Assistance Act. It is estimated that the current DBE work volume is slightly above the predicted capacity of the total DBE firms in Texas. The current work is being performed by approximately seven (7) percent of DBE firms and three (3) percent by WBE firms.

2. The SDHPT currently lists 550 certified DBE and WBE firms which is quite comparable to other state transportation agencies as reported in a recent AASHTO summary report. Of the work awarded to DBE's in 1986 and 1987, only twenty four

(24) percent of the certified firms actually performed work. Although the potential exists for an additional 145 DBE firms in Texas, it does not seem reasonable to actively recruit more certifications when seventy six (76) percent are not getting jobs now.

3. One problem that was identified was the SDHPT's DBE Support Services Program; it has not been as successful as other states. Attempts are currently underway to arrange for other arrangements to rectify this situation.

1.0 Introduction

1.1 Background

The Surface Transportation Assistance act of 1982 specified that at least ten (10) percent of all amounts authorized to be appropriated under this Act shall be expended with small business concerns owned and controlled by socially and economically disadvantaged individuals as defined by the Small Business Administration. These small business concerns are more commonly referred to as Disadvantaged Business Enterprises or DBE's, and the program implemented by the Federal Highway Administration (FHWA) to fulfill the requirements of the S.T.A.A. has become known as the DBE Program.

Since the passage of the S.T.A.A., each state has established its own separate DBE program and added staff to simply monitor and administer the DBE requirements. The programs have been the center of many political debates and controversies, with great pressures placed on highway departments to meet their goals while trying to prevent the creation of illegal firms, of "fronts", which are really not independent companies.

The S.T.A.A. was amended in 1987 to allow the ten percent goal to be met by an accumulation of the total volume of work performed by both DBE firms and WBE firms, known as Women Business Enterprises. This resulted in many highway construction firms seeking W.B.E certification; however, many of those applying were not approved as their owners were not deemed as qualified. This has caused a lot of controversy to add to the administrative chores of state agencies. In addition, the DBE contractors complain that it is not fair to allow WBE's to be included in their ten percent goals, but should have their own separate goals.

Each state transportation agency can set its own goals for the DBE Program and does not have to reach ten percent if it can justify a lower goal. However, very few states have been able to obtain approval for lower goals. The major difficulty for most agencies is the ability to accurately assess the true capability of minority firms in their state to perform highway construction work. The purpose of this study was

to assist the Texas State Department of Highways and Public Transportation in this area.

1.2 Study Objectives

The principle objective of this study was to develop a set of analytical procedures that will assist the SDHPT in defining and assessing the capacity of the DBE firms in Texas to do highway construction as participants in the DBE Program.

Major sub-objectives of the study were:

1. Establish a data base of Texas DBE firms (both DBE and WBE)for subsequent use in comparative analysis state wide, district wide, and in selected metropolitan areas, particularly Houston, Dallas-Fort Worth, and San Antonio.

2. Classify the population of DBE firms by geographic location, type of construction specialty, size, financial capabilities, technical capabilities, and other selected characteristics.

3. Document and assess the necessary characteristics of the firms in the DBE segment of the industry, to include (a) financial variables; (b) industrial, educational, professional, and entrepreneurial training experience; (c) other assets; and (d) other business experience.

4. Develop an analysis of the total amount of work available to DBE firms in Texas from all sources.

5. Develop techniques for projecting state wide and regional construction work capacities of the DBE sector.

6. Develop models for (a) identifying and updating the population of relevant firms, and (b) estimating the capacity of the DBE segment to do highway construction work.

2.0 Study Work Plan

2.1 Introduction

There were two general aspects of the research work performed in this study. The first was the collection of the data needed to carry out the objectives of the study. This data was sought from many different sources, such as research reports, magazine and journal articles, professional associations, city agencies, and from other state agencies. A major source of data for the study was from the SDHPT's own DBE data files. Finally, the main basis for the proposed analytical techniques and models was from questionnaires developed specifically for the study and distributed to both DBE firms and regular highway construction firms.

The second aspect of the research performed in this study was the analysis conducted to attempt to develop analytical techniques and models for estimating the ability or capacity of the DBE segment of the Texas Highway Construction Industry to participate in the SDHPT' annual work program. This involved the evaluation of the data collected using statistical methods to identify the significant characteristics of DBE firms to use in predicting a DBE's capacity to do work.

2.2 Description of Research Tasks

The specific tasks conducted as a part of the study were:

Task 1: Literature search for Existing Data. An extensive literature search was conducted as a part of this study to find sources of data for conducting the research tasks. Although a lot of information was found on DBE programs in many different transportation agencies, local, state, and federal, there were no prior studies found that specifically addressed the issue of predicting the capacity of DBE firms to perform highway construction work. Many groups contacted were interested in seeing the final report of this study. Some reports were found in the General Business (manufacturing area) which related to the prediction of failures of manufacturing firms based on certain common characteristics of the firm. Although they were not directly applicable, they did serve as general guidance for this study.

Task 2: Establish Data Collection Needs. Many efforts were undertaken to determine the possible data needed to carry out the research objectives of this study and potential reliable sources of this data. Visits were made with the SDHPT, AGC of Texas, minority contractors, DBE supportive services consultants, city contracting agents and others who agreed to support the study, although different opinions were expressed about the use of the results.

Task 3: Data Collection. All of the inputs on data collection needs were used in the development of the questionnaires which were to be the primary documents for data collection for the study. The results of the data collection via the questionnaires will be discussed in detail in Chapter 4 of this report. The other major source of support data for the study was the DBE Staff of the Construction Division of the SDHPT in Austin. The staff was very helpful in supplying both data and insight to the researchers during the entire study. Some data used in the study was found in many publications reviewed during the literature search.

Task 4: Analyze Data, Develop and Test Models. Data collected for the study was analyzed for relevance to the study objectives with appropriate data further analyzed using statistical procedures to identify those factors significant to predicting DBE work capacity. The data from the questionnaires ,along with data from SDHPT files was the primary source used to develop the prediction models studied in the research. Model development and interpretation is presented in detail in Chapter 5; while information on DBE firms in Texas is given in Chapter 3.

Task 5. Prepare Final Report. This is the final report of the study and presents a summary of all the activities undertaken as part of the research efforts and the findings of these efforts. It also contains specific recommendations for improving the SDHPT's DBE Program and for estimating the capacity of the DBE 's interested in highway construction work.

3.0 DBE Firms in Texas

3.1 Introduction

This chapter presents a statistical profile of the Texas DBE population. The categories covered include ethnic status, gender, education level, business characteristics, and type of work performed by district and region. The number of DBE's comprising this population, for this study, was derived from the December,1987 SDHPT Directory of Disadvantaged Business Enterprises and Women - Owned Business Enterprise by excluding firms engaged solely in engineering work and those listed as Truck - owner operators. Therefore , the population numbered 477 .

Section 3.2 covers non - business related statistics. Section 3.3 covers business and economic related statistics and section 3.4 presents the work specialty characteristics.

3.2 Ethnic , Gender and Educational Status of Texas DBE's

Table 3.1 depicts the ethnic and gender status of the Texas DBE owner. Women -owned Business Enterprises (WBE) comprise 22% of the population and their male counterparts make up 78%. These WBE's are overwhelmingly white and compose 17% of the Texas DBE population. On the other hand, the male group is heavily dominated by Hispanic - Americans , compromising 48% of this population. The dominance of these two ethnic segments probably reflects the relative socio-economic status of each with respect to other such ethnic segments.

The educational level of DBE owners was determined from questionnaires developed for this study. As seen in Table 3.2 , it shows that one - half of the respondents indicated that they received a high school/technical school education; 19% attested to attending or graduating from a junior college, and college degree DBE's comprised 31% of this sample.

Table 3.1 Ethnic and Gender Status of Texas DBE owners
n=442

Hispanic Female	1.1%	
Black Female	0.7%	
Other Female	3.6%	
White Female	7.0%	
Total Female		**22.4%**
Hispanic Male	47.5%	
Black Male	19.2%	
Other Male	10.9%	
Total Male		**77.6%**
Total		**100.0%**

Table 3.2 Educational Status of Texas DBE Owners
n=72

High School/Technical	50.0%	
Junior College	19.4%	
B.S. ,other fields	15.3%	
B.S. ,engineering	8.3%	
Graduate degree	6.9%	
Total		**100.0%**

3.3 Business and Economic Statistics

Table 3.3 displays the business experience of Texas DBE's. Firms that have at most 5 years experience compromise 67% of the population;firms having 6-10 years experience make up 17% of the population; firms having 11 -15 years experience make up 8% of the population; firms having 16-20 years experience make up 4% of the population and firms having over 20 years of experience make up 4% of the population. It is evident that the S.T.A.A. of 1982 has had a substantial impact on the number of highway related DBE's formed in Texas. Two-thirds of Texas certified DBE's have been created since the establishment of the goals included in the S.T.A.A. of 1982. However, this is a foreboding statistic. Table 3.4 shows the failure rate for all U.S. business firms. From this it is observed that the failure rate is inversely proportional to the number of years of business experience. The category with the highest business failure rate is the same category that comprises 67% of Texas DBE's.

Table 3.3 Age of Business for Texas DBE's n=477

Years	%
0-5	67.1
6-10	16.8
11-15	8.0
16-20	4.0
21 or more	4.0
Total	**100.0**

Table 3.4 Failures by Age of Business for the Total Construction Industry * n=7,109

Years	%	
0-5	43.9	
6-10	29.8	
11 or more	26.3	
Total		**100.0**

* Source: The Dunn & Bradstreet Corp., "Business Failure Record",1986

Table 3.5 Number of Employees of Texas DBE's n=77

0-10	55.8%	
11-20	22.1%	
21-30	5.2%	
31-40	9.1%	
41-50	1.3%	
>50	6.5%	
Total		**100.0%**

Tables 3.5 and 3.6 portray the distributions of the number of employees and the number of projects in the last 5 years , respectively. According to Table 3.5, over one-half (i.e. 55.8%) of the DBE's (N=77) responding have 10 or fewer employees.

Table 3.6 reflects the fact that, of the 53 DBE's responding to this section of the questionnaire, almost two-thirds of DBE's averaged fewer than 4 projects per year during the last 5 year period.

Table 3.6 Project Experience of Texas DBE's
n=53

0-20	66.0%
21-40	7.5%
41-60	5.7%
61-80	0.0%
81-100	1.9%
101-120	1.9%
121-140	0.0%
> 140	17.0%
Total	**100.0%**

Tables 3.7 through 3.9 portray the financial background of Texas certified DBE's. Well over one-half of Texas DBE's have less than $250,000 in total assets, as seen in Table 3.7 , while almost 13% of DBE's report total assets of over $1,000,000 . Table 3.8 provides a financial balance sheet and revenue profile for the average Texas DBE. From 1984 to 1987 revenue has remained essentially flat (i.e. within a range of +/- 12% of 1984 revenues), as has the total assets (i.e. $498,700 in 1984 to $487,900 in 1987). Net fixed assets have decreased significantly (i.e. down approx. 25%). This may be due to depreciation or selling off fixed assets to enable the firms to gain liquidity. In any event, it does appear that there is a decrease in fixed assets, perhaps indicating that DBE's do not feel revenue will substantially increase on a long term basis to justify increased capital spending. In the same manner, net worth has decreased about 11% since 1984. This may indicate a poor profitability picture for Texas DBE's .

Table 3.7 Total Asset Size of Texas DBE's
n=289

$	
0-250,000	56.4%
250,001-500,000	15.9%
500,001-750,000	9.0%
750,001-1,000,000	5.9%
1,000,001-1,250,000	3.1%
> 1,250,000	9.7%
Total	**100.0%**

Table 3.8 Financial Profile of Average Texas DBE

	$(000)			
	1987	1986	1985	1984
Revenue	1,021.9	1,276.4	1,252.6	1,137.7
Current assets	300.8	283.0	347.4	244.2
Net fixed assets	187.1	227.1	200.9	254.5
Total assets	487.9	510.1	548.3	498.7
Current liabilities	223.5	211.6	218.2	200.3
Long-term lia.	141.2	148.7	155.6	161.0
Net worth	123.2	149.8	174.5	137.4
Total lia. & net worth	487.9	510.1	548.3	498.7
Sample size	86	140	96	49

Table 3.9 Financial Ratio Analysis

					4-Year Dunn & Bradstreet Avg's		
	1987	1986	1985	1984	UQ	MED	LQ
Solvency:							
Current ratio	1.3	1.3	1.6	1.2	2.7	1.6	1.1
Curr. liab./Net worth	181.4%	141.3%	125.0%	145.8%	26.3%	62.2%	131.9%
Tot. liab to equity	296.0%	240.5%	214.2%	263.0%	42.8%	97.9%	201.7%
Rev./Wrkg. cap. ratio	13.2	17.9	9.7	25.9	5.2	9.6	19.1
Capitalization adequacy:							
Revenue/Net worth	8.3	8.5	7.2	8.3		4.3	

Table 3.9 presents a financial ratio analysis of the data contained in Table 3.8. When compared to the 4 year Dunn & Bradstreet averages , two things stand out :

1. Solvency remains a problem. All solvency ratios are well below the construction industry median values. Two of four of these key solvency ratios , current liabilities/net worth and total liabilities/net worth are well below the D & B lower quartile value, while the current ratio ,and revenue /working capital are at a level at which approximately 67% of construction firms are better off.

2. The DBE segment still remains under capitalized. The revenue/net worth ratio has been constant from 1984 to 1987. However, this ratio is twice the D & B reported median value.

3.4 Work Specialty Characteristics of Texas Certified DBE's

Table 3.10 shows the work composition of Texas DBE's broken down by region and district within the region. This table indicates that hauling , minor structure work and earth moving are well represented throughout Texas. However, work requiring capital intensive equipment, aside from earthwork, such as asphalt paving and concrete work appear to be under represented.

Table 3.10 Texas DBE by Specialty and District

	West Region Districts										Central Region Districts							Northern Region Districts										Out of State	
	3	4	5	6	7	8	23	24	25	**Total**	12	13	14	15	16	21	**Total**	1	2	9	10	11	17	18	19	20	**Total**		**Grand Total**
# DBE	4	10	13	10	1	9	1	13	0	**61**	88	14	33	57	26	27	**245**	6	34	7	9	3	11	48	9	15	**142**	**29**	**477**
Specialty																													
Asphalt	0	2	1	1	1	2	0	1	0	**8**	7	0	1	2	3	5	**18**	0	1	1	1	0	1	6	3	2	**15**	**5**	**46**
Concrete	0	1	0	0	0	2	0	2	0	**5**	6	0	1	1	1	1	**10**	0	0	1	0	0	0	6	1	1	**9**	**3**	**27**
Earthmoving	0	4	2	2	1	3	0	5	0	**17**	17	3	11	13	3	7	**54**	1	4	1	4	1	3	15	4	6	**39**	**10**	**120**
Fencing	1	4	3	2	0	3	1	1	0	**15**	13	4	3	8	4	2	**34**	1	5	0	0	0	3	6	2	6	**23**	**6**	**78**
Hauling	1	3	6	6	1	3	0	3	0	**23**	23	9	9	16	15	17	**89**	3	15	1	2	1	6	26	3	8	**65**	**7**	**184**
Illumination	0	0	0	1	0	1	0	0	0	**2**	5	0	2	5	1	0	**13**	0	1	0	0	1	0	0	1	1	**4**	**2**	**21**
Landscape	0	1	0	2	0	1	0	0	0	**4**	9	3	7	7	1	2	**29**	0	3	2	2	0	2	4	3	3	**19**	**4**	**56**
Major struct.	2	1	1	0	0	2	0	5	0	**11**	11	0	3	10	2	1	**27**	0	6	0	0	0	0	8	1	1	**16**	**5**	**59**
Material sup.	0	0	0	0	0	0	0	1	0	**1**	7	0	0	6	1	3	**17**	1	4	0	0	0	0	2	1	0	**8**	**5**	**31**
Minor struct.	2	7	5	3	1	3	1	8	0	**30**	39	4	16	21	5	7	**92**	3	5	3	3	2	3	2	4	8	**33**	**8**	**163**
Painting	0	3	2	1	0	1	0	2	0	**9**	2	0	2	2	2	1	**9**	0	0	1	0	0	0	17	1	2	**21**	**2**	**41**
Rest areas	0	2	3	1	0	0	0	2	0	**8**	9	1	2	6	1	2	**21**	0	0	0	0	0	0	2	2	2	**6**	**1**	**36**
Traffic cont.	0	0	1	2	0	2	0	1	0	**6**	5	1	3	7	4	0	**20**	1	4	1	2	0	1	1	2	2	**14**	**2**	**42**
Misc.	0	0	1	2	0	1	0	0	0	**4**	7	0	3	5	3	2	**20**	0	2	1	1	1	0	2	0	2	**9**	**3**	**36**

4.0 Data Collection Effort

4.1 Introduction

This chapter discusses the data collection effort of the research team. This effort consisted of :

1. Reviewing DBE certification files kept by the SDHPT

2. Study awareness and information gathering

3. Questionnaire development and mailing

4.2 Review of DBE Certification Files

The SDHPT files of schedule A firms are not computerized and therefore required a manual search. These files generally contain:

1. Resumes of owners/managers

2. Amount and type of equipment owned or leased

3. Financial balance sheets with revenue statements (income statements are not required)

4. Statement of bonding capacity

5. Nature of business

6. Applicable articles of incorporation and corporate bylaws /minutes

Information concerning the quality of work performed , ability of the firm to be at a site on time, completing the project on time , bill paying habits, and other indicators of job performance is not available. As discussed in the following chapter , all of the information contained in these files was relevant to the study.

4.3 Study Awareness and Information Gathering

Since this study deals with very sensitive policy issues, it was determined that affected groups should be made aware of the research being conducted. Information from these groups was incorporated into the study data base. The primary goals behind this effort was to:

1. Introduce the objectives, methodology and expectations of the study

2. Solicit information and cooperation of pertinent organizations and agencies

3. Familiarize the research team with the nature and scope of the association of each group with DBE's.

This effort was accomplished through meetings with and presentations to major municipal agencies, metropolitan transit authorities, contractor organizations, and Support Service Contractors of the SDHPT. These included:

- Houston's METRO
- City of Houston
- American Surety Co.,Houston
- Construction Assistance Center, Houston
- City of Dallas
- Dallas' DART
- American Subcontractors' Association, Dallas
- WAUSAU Insurance Co., Dallas
- Minority Business Development Council, Dallas
- City of San Antonio

- San Antonio's VIA
- National Association of Women in Construction, San Antonio
- City of Corpus Christi
- RTA, Corpus Christi
- Group of Minority Firms attending the Bonding & Financial Services seminar, Corpus Christi
- DBE Contractors' Alliance , Nacogdoches
- Capital Metro, Austin
- AGC, Austin
- SDHPT's Support Services Contractors in Austin

Only one meeting was held with each group, with the exception of the Associated General Contractors (AGC) .

In addition to these meetings, letters were sent to Texas cities and transit agencies introducing the DBE study, and soliciting cooperation in data collection. Cities that were consulted included all of the above and others such as: Abilene, Amarillo, Arlington, Beaumont, Brownsville, Denison, El Paso, Fort Worth, Galveston, Garland, Howe, Irving, Laredo, Lubbock, McAllen, Midland, Port Arthur , San Angelo, Sherman, Victoria, Waco, and Wichita Falls.

4.4 Questionnaire Development and Mailing

The questionnaire was developed from a variety of sources: meetings with SDHPT personnel, Support Service Contractors (SSC), review of Schedule A forms , and related literature [ ]. Once preliminary questionnaires were developed, they were sent to a number of interested parties, such as the AGC, SSC, DBE Contractor Alliance, and some municipal representatives. From the comments and suggestions

received from these organizations, the questionnaire was further refined and completed.

To elicit as much participation as possible, the following procedure was implemented:

1. Initial mail out with postage paid self addressed return envelope

2. Follow up post card reminder for firms not completing the questionnaire within a six week period

3. Telephone follow up to major DBE's

Table 4.1 summarizes the mailing and the responses received.

Table 4.1 Study Mailing Effort

Group	Number Mailed	Number Returned	Number Usable
SDHPT Certified DBE	477	72	63
Non-Certified DBE	791	30	22
Prime Contractors	420	72	51

5.0 Work Capacity of DBE's in the Texas Highway Construction Industry

5.1 Introduction

In this chapter the present and potential DBE highway contractors' capacity is estimated. Sections 5.2 through 5.5 present the development and application of the DBE highway contractors' capacity forecasting model. Several methods of estimating annual capacity are discussed and evaluated, along with the derivation of the capacity forecasting model. This model , so developed, is then employed to forecast the annual state wide capacity of DBE's currently certified by Texas State Department of Highways and Public Transportation (SDHPT).

Section 5.6 introduces the methodology used to estimate the number of DBE's which can be certified to perform highway related work. The highway capacity forecasting model is subsequently applied to these possible certified DBE's , and an estimate of the potential DBE highway contractors' capacity is provided in section 5.7.

5.2 The Basic Capacity Forecasting Model

The state wide highway capacity (in dollars) of certified DBE's can be partitioned into two components:

1. The amount of revenue produced annually by DBE's.
2. The proportion of DBE's annual revenue derived from state highway work.

Therefore , the basic capacity forecasting model can be expressed as

$$S_t = 0.1584 \sum_i R_{ti} \qquad i=1,2,...n \qquad (5.1)$$

where S_t = expected maximum $ contracted to DBE's in year t (i.e. state wide DBE highway capacity)

R_{ti} = annual $ capacity of i^{th} DBE in year t

The factor 0.1584 represents the average proportion of the revenue derived from state highway subcontracts/contracts for DBE's. It is the product of two proportions:

1. The proportion of certified DBE's winning a state highway subcontract (i.e. 24%), and
2. The proportion (i.e. 66%) of a DBE's revenue earned via state highway work, given that the DBE has won an award.

These two proportions were obtained by examining 1986 and 1987 SDHPT DBE/WBE construction reports along with DBE financial statements, and represent the average of the two years.

5.3 Methods of Estimating Capacity R_{ti}

A review of financial and management literature reveals that no sure method for calculating the business capacity of a company exists per se. The literature does imply that there are logical procedures which can be employed to assess capacity. According to this literature, a viable firm (i.e. one that will be solvent) has adequate capital [2,9,16], can generate suitable profits or cash flow relative to debt [2,4,6] and has sufficient liquidity [6,9,12].

Five different methods based on these aforementioned characteristics can be used to estimate annual capacity:

(1) The Net Worth Method

(2) The Revenue Method

(3) The Regression Method

(4) The Minimax Method

(5) The Working Capital Method

5.3.1 The Net Worth Method

In this method capacity is a multiple of net worth, calculated as follows:

$$R_{ti} = 14.2\ NW_{(t-1)i} \qquad (5.2)$$

where $NW_{(t-1)i}$ = net worth in year t-1 of i^{th} DBE

The rationale behind using net worth is that it is a permanent source of funding,it provides a rough indication of the firms profitability, and it is an approximation of the amount of protection afforded creditors. In turn, the viability of a contractor depends upon his ability to receive credit.

The multiplier 14.2 is a threshold number equal to the ratio of sales to net worth found by Edmister [9]. In this study , it was determined that small businesses that have ratios higher than this amount "do not have adequate capital " to support such sales. This particular threshold value was found to be one of several statistically significant predictors of small business bankruptcy.

5.3.2 The Revenue Method

In this method capacity is defined as

$$R_{ti} = 2\ Rmax_{(t-1..)i} \qquad (5.3)$$

where $Rmax_{(t-1..)i}$ = highest revenue earned prior to year t for the ith DBE

The multiplier 2 was obtained from Russell [14],in which he suggested that this multiple is the maximum that a contractor could reasonably expect to manage. The assumption behind this method is that past work load experience, as expressed by revenue, influences future work load performance.

5.3.3 The Regression Method

In this method, capacity was predicted via multiple regression techniques employing Texas DBE's as the data base. The type of data under consideration evaluated the DBE's financial resources (as derived from financial statements), bonding capacity, human resources (such as work and business experience), and other factors like geographic location, sex/race of owner , and work specialty. This information was obtained through the SDHPT DBE files and the questionnaires sent to DBE's.

It was desired that the regression model be based on lagged variables (i.e. independent variables for year t-1 given that the response variable is for year t) as the previous three models . Only DBE's which had reported complete financial statements for two consecutive years could be considered. Furthermore, other factors reduced the pool of DBE's which qualified for the multiple regression analysis. Firms which had negative net worth (i.e. insolvent firms) or those that did not report financial statements reflecting generally accepted accounting procedures were omitted as well. From approximately 500 certified highway related DBE's (i.e. engineering firms and trucking firms not engaged in hauling were not considered) the number of firms meeting the aforementioned criteria was reduced to 90 .

The independent variables for this multiple regression model were selected using the stepwise computer selection procedure. This procedure starts with the "best" one-variable equation , but before adding subsequent variables, the statistics are examined for insignificance in which case the variable is eliminated and another variable chosen. The procedure terminates for specified significance levels when variables can neither be added nor deleted [10]. This procedure was modified slightly for this study in which goodness of fit criteria were considered as well. This led to a model in which one parameter was included which did not have the same level of statistical significance as the others selected, but did achieve a better fit.

From the collection of variables considered in Table 5.1, four statistically significant variables were selected which had the most explanatory power. These were : total assets(TA), long-term debt(LTD), total assets x bonding capacity in dollars (TA*BOND) , and working capital (WC)

Table 5.1 Variables Considered for Selection

Code	Description
NORG	Proprietorship (1),partnership (2),corporation (3)
NBUSYRS	Number of years in business
BOND	Bonding capacity in $(000's)
HIREV	Highest Revenue in $(000's)
CA	Current assets in $(000's)
TA **	Total assets in $(000's)
CL	Current liabilities in $(000's)
LTD **	Long-term debt in $(000's)
TLIA	Total liabilities in $(000's)
N W	Net worth in $(000's)
WC **	Working capital in $(000's)
LBOND	Whether of not firm is bondable (1=yes,0=no)
TCAP	NW + LTD
TA*BOND **	Total assets times bonding capacity
TREND	Trend in revenue (1=increase,0=same,-1=decrease)
LOC	Geographic location of business (code used)
DENS	Population density of location
ETHNIC	Ethnicity /sex of owner (1=Black male,2=Hispanic male , etc,)

** "Best" variables selected

Table 5.2 depicts the various statistical tests of the regression model . First, the regression model has adequate goodness of fit as shown by the adjusted coefficient of determination (adj. R2) of 0.698 . It explains approximately 70 % of the deviations (e.g. perfect explanatory power would require R2 to be 100%). An illustration of goodness of fit is provided in Figure 5.1 in which the predicted values of the regression model ,so derived, is compared to the actual data values. Perfect fit would mean that the data would lie exactly along the line. Secondly, the Analysis of Variance test reveals that a statistically

Figure 5.1 Goodness of Fit for Regression Model

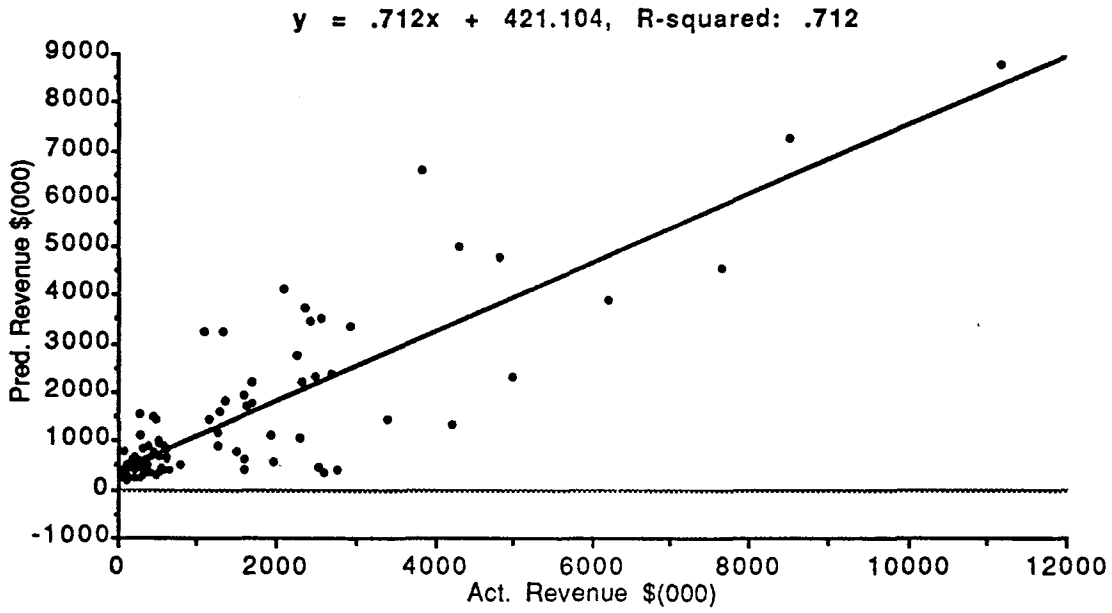

Table 5.2 Regression Model Statistical Tests

Multiple Regression Y_1:REV 4 X variables

DF:	R:	R-squared:	Adj. R-squared:	Std. Error:
89	.844	.712	.698	1069.933

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	4	240439428.697	60109857.174	52.509
RESIDUAL	85	97304276.225	1144756.191	p = .0001
TOTAL	89	337743704.922		

Multiple Regression Y_1:REV 4 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
INTERCEPT	198.374				
TA	2.36	.263	.93	8.97	.0001
LTD	-2.392	.633	-.363	3.78	.0003
TA*BOND	1.723E-4	4.920E-5	.233	3.503	.0007
WC	.286	.186	.092	1.541	.127

significant model ($a \leq 0.0001$) was developed. The chance that at least one of the parameter coefficients is equal to zero is 1 in 10,000 . Finally, the test of the individual parameter statistics (t- values) reveals that three of the parameters (i.e. TA,TA *BOND,LTD) are highly significant($a < 0.05$) while WC does not have this level of significance (i.e. the chance that the coefficient of WC=0 is less than 13 in 100). We can furthermore conclude, from the direction of the coefficients, that total assets, bonding capacity and working capital positively affect future revenue while long-term debt has a tendency to reduce future revenue. Hence, large unleveraged, liquid DBE's who are able to secure bonding should produce the greatest revenue.

Since capacity is the maximum annual revenue that a firm can manage consistent with its financial and human resources, the upper 99% confidence intervals for the 4 parameters are used as the coefficients for this model. Upper 100(1-a) % confidence estimates, $B_{(1-a)j}$, are constructed by the following formulation [10]:

$$B_{(1-a)j} = b_j + t_{(a,df)} s (c_{jj})^{0.5} \qquad (5.4)$$

where

b_j = j^{th} parameter coefficient estimate
s = estimate of standard error
$t_{(a,df)}$ = t-value for a and df degrees of freedom
c_{jj} = jth row and column element of the variance-covariance inverse matrix C

Therefore DBE capacity is estimated using the following regression

$$R_{ti} = 198.374 + 3.053TA - 0.724LTD + 0.000302TA*BOND + 0.775WC \qquad (5.5)$$

All quantities for the above variables are expressed in thousands.

5.3.4 The Minimax Method

The minimax method selects the minimum estimate of the previous three capacity (maximum revenue) methods applied to an individual DBE. It can be expressed as

$$R_{ti} = \min \{ R[1]ti, R[2]ti, R[3]ti \} \quad (5.6)$$

The numbers in brackets [1]-[3] signify net worth, revenue, and regression methods respectively.The working capital method was omitted because it was believed that there may be accounting classification problems concerning current liabilities resulting in negative working capital, or some valid relationships between a DBE and prime contractor permitting assistance in bill paying ability. Also, the regression method puts some weight on working capital.

The underlying concept of this method is that of conservatism. Recall, that the lack of net worth has been significantly associated with bankruptcy. Hence, some measure of upper bound should be instituted.

5.3.5 The Working Capital Method

Working capital is defined as the excess of current assets over current liabilities ,and the ratio of revenues to working capital is used as a measure of adequate liquidity by both the Robert Morris Associates and Dunn & Bradstreet credit rating agencies. In addition,lack of adequate working capital was found to be a significant factor leading to bankruptcy [2,4].

This method calculates capacity as

$$R_{ti} = 20\ WC_{(t-1)i} \quad (5.7)$$

where $WC_{(t-1)i}$ = working capital in year t-1 for the ith DBE

The multiplier 20 is essentially that used by the SDHPT for evaluating the bidding capacity of pre-qualified prime contractors. Although there is nothing sacrosanct about the value 20, this does place DBE's on an equal evaluation basis with Texas prime contractors, and it is more than twice the median value for typical highway contractors [8].

5.4 Evaluation of the Capacity Methods

Table 5.3 offers a comparison of the multiplier values used by this study for the working capital, net worth and revenue methods, and the values from five large capitalized general contractors - Blount, Morrison-Knudsen, Perini, Fluor, and the Slattery Group.

Table 5.3 Comparison of Multiplier Values

Method	DBE Multiplier	Large Capitalized General Contractors (N=5) Minimum	Median	Maximum
Working Capital	20.0	5.4	16.9	130.0
Net Worth	14.2	3.0	5.7	8.7
Revenue	2.0	1.0	1.3	1.5

The data were obtained from the Value Line Investment Survey [15] and represented the maximum values for each firm over the last five years. In each case the DBE multiplier exceeds the median value for these very large publicly traded general contractors. For both the net worth and revenue methods, the DBE multipliers exceed the sample values of these contractors. This is what one would desire for a number which purports to be a reasonable maximum. The working capital method does not achieve this, which suggests that this method may have too much variability to be a good predictor of capacity. In conclusion , each multiplier for these methods exceed the median value of several highly successful construction

management firms and in the heavy construction industry. The multipliers suggested in this study appear to be both adequate and reasonable maximum values.

Table 5.4 summarizes the advantages and disadvantages of each of the methods presented. Each of the three multiplier methods has a drawback in that they base capacity upon a single factor. The net worth and revenue methods have the advantage that they appear to be fairly consistent when compared to the large capitalized contractor values presented in Table 5.3 . The working capital method does not achieve this, but is widely used in the bonding industry.

Table 5.4 Evaluation of Capacity Estimation Methods

Method	Advantages	Disadvantages
Working Capital	• emphasizes importance of liquidity • wide acceptance in bonding industry	• values too volatile for good predictor • account problems • considers only one factor
Net Worth	• emphasizes importance of retained earnings & start up capital • fairly consistent predictor* • valid predictor of business failure	• considers only one factor • can not measure explanatory power of model
Revenue	• most consistent predictor* • considers past experience	• considers only one factor
Regression	• several factors considered • procedure can measure explanatory power of model	• explanatory power of model adequate , but not exceptional
Minimax	• considers 3 methods • conservative estimates • provides upper bounds	

* as compared to Table 6 . Comparison of Multiplier Values

With respect to DBE's, this method may present accounting classification problems . The regression method overcomes the disadvantages of the other three in that several factors are considered. However, the regression model does not

entirely explain the DBE revenue producing process. The minimax method has the advantage that it uses all of the methods discussed ,except working capital, provides a conservative estimate, and seeks to place an upper bound on the estimates which is consistent with the financial research on bankruptcy . All the methods have merit in their own right, however, the minimax method is judged to be the most reasonable method to employ.

5.5 Estimation of State wide Capacity

Texas DBE capacity is estimated by eq. (5.1) ,where the values of Rti are computed using the minimax method as expressed by eq. (5.6) . Table 5.5 provides example calculations for Texas DBE capacity.

Table 5.5 Example Calculations for DBE Capacity

		Required Financial Information						Capacity Estimation Method			
Firm	High Revenue	TA	LTD	BOND	TA*BOND	WC	NW	R[1]	R[2]	R[3]	R[4]
1	46.0	42.0	0.0	0.0	0.0	2.9	33.4	474.3	92.0	328.8	92.0
2	1400.0	406.0	180.0	200.0	81200.0	145.3	204.0	2896.8	2800.0	1444.7	1444.7
.											
.											
.											
N	6200.0	3038.2	1549.4	0.0	0.0	964.6	697.4	9903.1	12400.0	9099.8	9099.8

Total Capacity of Texas DBE's =.1544 *SUM(R[4])

First, the three maximum methods, designated R[1]-R[3] on Table 5.5 , are applied to each firm. Second, for each firm the minimum value , designated R[4], is calculated. Third, the state wide capacity is found by summing the R[4] column and multiplying by the factor of 0.1584 as indicated by eq. (5.1) . For firms which do not provide essential pieces of financial information required by this procedure,the average DBE capacity (i.e. $0.1584\sum R[4]/N$) is used.

Table 5.6 gives the 1988 DBE capacity estimates for the Western, Central and Northern regions of Texas, as well as those derived from those DBE's headquartered out of state. For the state, it is estimated that $81,000,000 can be done by DBE's

working in Texas. More than 53% is expected to come from the Central portion of the state, 26.5% from the Northern districts and approximately 9% from the Western region of Texas. Of special note is that, according to this model, Texas would rely upon 11% of its expected capacity from out of state sources.

Table 5.6 Estimation of DBE Capacity for 1988

Region	Estimated Capacity $(000's)	
Out of State	8,900	11.0%
West Texas Districts: 3-8,23-25	7,600	9.4%
Central Texas Districts: 12-16,21	43,000	53.1%
North Texas Districts: 1,2,9-11,17-20	21,500	26.5%
Total	**81,000**	**100.0%**

5.6 Estimation of Potential DBE's in Texas

The number of DBE's which are capable of, and desire to, perform highway related work was estimated by the multiple regression technique employing data gathered by an AASHTO survey [1]. The regression equation was found to be

$$NDBE = -135.839 + 0.865\,MPOP + 26.516\,INC - 0.0002092\,MPOP2 + 0.000006696\,MPOP3 - 0.073\,MPOP*INC \quad (5.8)$$

where

NDBE = the number of DBE's
MPOP = the minority population in 103
INC = the per capita income for a state in 103

Table 5.7 summarizes the analysis of eq. (5.8) . First, this model is highly correlated with the number of DBE's and explains over 81% (i.e. adjusted R2=0.813) of the deviations from the prediction line. As in section 5.3.3 ,Figure 5.2 illustrates the meaning of this value. From the Analysis of Variance it is observed that eq. (5.8) is highly significant. (The p-value of 0.0001 means that there is at most a 1 in 10,000 chance that at least one of the parameter coefficients is of a trivial effect.) The Beta coefficient Table shows that all of the parameters have a high degree of statistical significance (i.e. Pr≤0.0013).

Table 5.7 Statistical Analysis of NDBE Model

Multiple Regression Y_1:NDBE 5 X variables

DF:	R:	R-squared:	Adj. R-squared:	Std. Error:
28	.92	.846	.813	41.301

Analysis of Variance Table

Source	DF:	Sum Squares:	Mean Square:	F-test:
REGRESSION	5	215927.817	43185.563	25.317
RESIDUAL	23	39233.631	1705.81	p = .0001
TOTAL	28	255161.448		

Multiple Regression Y_1:NDBE 5 X variables

Beta Coefficient Table

Parameter:	Value:	Std. Err.:	Std. Value:	t-Value:	Probability:
INTERCEPT	-135.839				
MPOP	.865	.15	6.141	5.757	.0001
INC	26.516	7.595	.389	3.491	.002
MPOP^2	-2.092E-4	7.725E-5	-3.78	2.708	.0125
MPOP^3	6.696E-8	1.898E-8	3.365	3.528	.0018
MPOP*INC	-.073	.014	-4.881	5.249	.0001

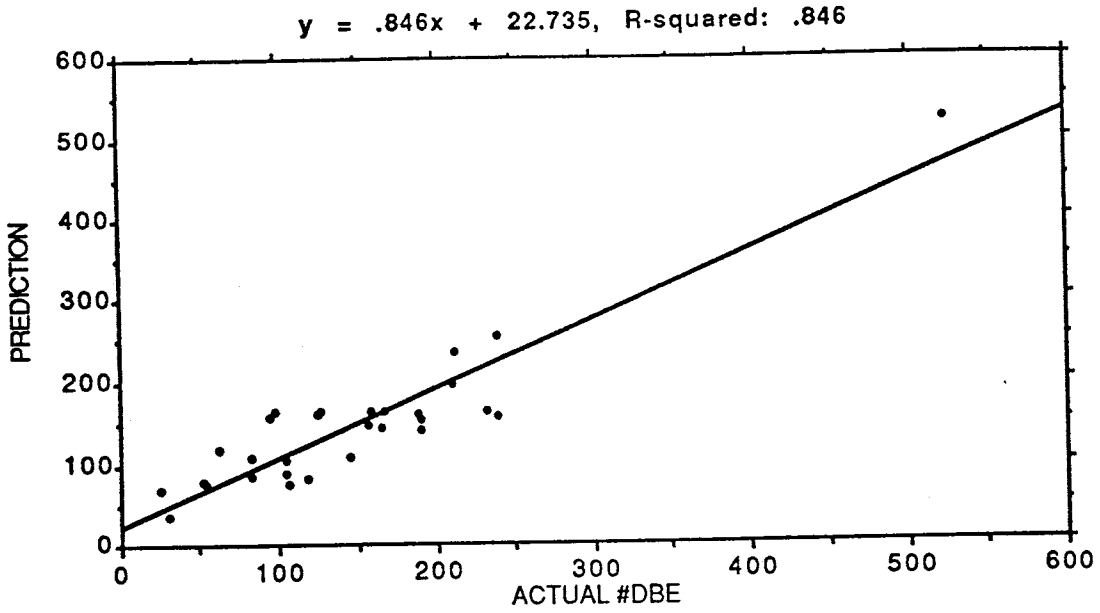

Figure 5.2 Goodness of Fit for NDBE Model

Based on a minority population of 2926.1 x 103 and a per capita income of \$9.443 x 103 the estimated number of highway related DBE's that Texas should have , based on eq. (5.8) , is 522. This is just 3 DBE's less than that reported by Texas to AASHTO. To estimate the most additional DBE's Texas could have (i.e. with Pr ≤ 0.01 that there could be more) a one sided 99% confidence increment, $\Delta_{(.99)}$, is calculated [7] by

$$\Delta(.99) = t_{(.01,23)} s (X_i' C X_i + 1)^{0.5} \qquad (5.9)$$

where

t(.01,23) = t-value with a = 0.01 and 23 degrees of freedom=2.5

s = standard error of the model(i.e.(MSE)0.5)=41.3

X_i' = the vector (1 X_{i1} X_{i2} X_{i3} X_{i4} X_{i5}) of values depicting data point i

C = inverse of the variance-covariance matrix

By substitution of the values 2926.1 (Minority population in 1983), 9.443 (per capita income in 1983), $(2926.1)^2$, $(2926.1)^3$,(2926.1 x 9.443) into Xi' and Xi , the value of eq. (5.9) is 145. Based on this regression, the probability that Texas has more than

145 potential DBE's is 0.01, or 1 percent . However, there is no way to verify this or to determine if these firms would be interested in pursuing an already highly competitive highway market.

5.7 Estimation of Potential Increase in Capacity

The potential increase in capacity of DBE highway work can be calculated as

$$\text{Potential Increase} = \text{NDBE} \times \text{AVGCAP} \qquad (5.10)$$

where AVGCAP = average capacity of DBE
$= 0.1585\ N^{-1}\Sigma R[4]$
= \$170,000

Hence by eq. (5.10) the potential increase in DBE capacity is \$24,650,000 on a yearly basis.

6.0 Summary and Recommendations

6.1 Summary

The primary objective of this study was to develop a set of analytical procedures to enable the SDHPT to better estimate the capacity of DBE firms in Texas to perform highway construction work. In addition, several observations and comparisons of the DBE program in Texas and the SDHPT's efforts were made during the study with data provided on other state programs. A summary of the findings of the study are presented here:

(a) It was difficult to develop prediction models for estimating the capacity of DBE firms since many of the factors controlling these estimates are highly qualitative and not quantitative. The formulas developed are believed to be statistically significant with about seventy percent of the deviations in the data explained. It was much more difficult to obtain the desired data to develop the models than anticipated. The information from SDHPT files and from the limited questionnaire responses were used, but future efforts to collect data would be desirable.

(b) Using the prediction models developed and other methods found from the studies, it is the opinion of the researchers that the DBE contractors are working at their capacity on SDHPT projects. actually, they are doing about 10 percent more work volume at the present time than their capacity as estimated in this study. Since any prediction has upper and lower bounds, it appears that the current DBE work volume is quite reasonable.

(c) Texas is in compliance with the DBE requirements of the FHWA for federally-funded transportation projects. The EEO staff are very cooperative and dedicated to their tasks. The SDHPT data files on DBE

contractors are not as up to date with financial data as expected, which made the study more difficult.

(d) The current DBE work load for SDHPT work is being conducted by approximately seven (7) percent DBE firms and three (3) percent by WBE firms. It is estimated that of those DBE firms doing SDHPT projects, sixty six (66) percent of their total work load is SDHPT work. The remainder of their work appears to be local, municipal, county, or private work.

(e) A review of the DBE databases developed or gathered for the study reveals about 550 DBE firms on the SDHPT list of certified firms; this is very comparable to all other agencies as reported in a recent AASHTO summary report. It is estimated that the potential exits for an additional 145 DBE firms to qualify in Texas. Of the firms certified in 1986 and 1987, only twenty four (24) percent actually had work on SDHPT projects. It appears that there is no justification to actively solicit more DBE firms to seek certification.

(f) The major cities in Texas appear to be meeting their goal for MBE's for construction work, although many are still organizing to manage these efforts. Houston appears to have a very good system in operation and is achieving a goal of fifteen (15) percent. They have a larger EEO organization than the SDHPT.

(g) SDHPT's support services program for DBE firms has not been as successful as other states. On the average state departments are contributing twenty six percent of their total support services funds, while Texas contributes zero. Texas offers most of the services that the other states do, except for financing and support to start a business.