MACROECONOMIC STUDY OF CONSTRUCTION FIRM'S PROFITABILITY USING CLUSTER ANALYSIS

A Thesis

by

PARTH ARORA

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

August 2012

Major Subject: Construction Management

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Approved by:

Co-Chairs of Committee,	Mohammed Haque
	Kunhee Choi
Committee Member,	Sarah Deyong
Head of Department,	Joseph Horlen

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ABSTRACT

Macroeconomic Study of Construction Firm's Profitability Using Cluster Analysis.

(August 2012)

Parth Arora, B.E., Birla Institute of Technology and Sciences

(BITS), Pilani, Rajasthan, India

Co-Chairs of Advisory Committee: Dr. Mohammed Haque
Dr. Kunhee Choi

This research aims to identify important factors contributing to a construction firm's profitability and to develop a prediction model which would help in determining the gross margin/profitability of a construction firm as a function of important parameters. All the data used in the research was taken from U.S Census Bureau reports. The novelty of the research lies on its focus at a state level, by dividing states into pertinent clusters and then analyzing the trends in each cluster independently.

The research was divided into two phases. Phase 1 of the research focused on identification of the most important factors contributing to gross margin of a construction firm. The variables used were derived from the U.S Census Bureau data. Based on the independent variables and gross margin, all the states were divided into three clusters. Subsequently, a prediction model was developed for each cluster using step-wise backward elimination, thus, eliminating non-significant variables.

Results of Model 1 gave impetus to developing Model 2. Model 1 clearly showed that labor productivity was the most important variable in determining gross margin.

Model 2 was developed to predict gross margin as a function of single most important factor of labor productivity. Similar to Model 1, states were clustered based on their labor productivity and gross margin values. Prediction model was developed for each cluster.

In this study, an excel embedded decision support tool was also developed. This tool would aid the decision-makers to view the state's level of gross margin and labor productivity at a glance. Decision support tool developed was in the form of color-coded maps, each of which was linked to a spreadsheet containing pertinent data.

The most important conclusion of the research was that there exists a positive linear relationship between labor productivity and gross margin at a state level in the construction industry. The research also identified and quantified other important factors like percent of rental equipment used, percent of construction work sub-contracted out and percent of cost of materials, components and supplies which affect gross margin.

DEDICATION

Dedicated to the 3 most beautiful women in my life – my mother, my sister and my wife:

Monica Arora

Saumya Arora

Simran Arora

ACKNOWLEDGEMENTS

I would like to extend my whole-hearted thanks to my committee chair and co-chair, Dr. Mohammed Haque and Dr. Kunhee Choi, and my committee member, Dr. Sarah Deyong for their guidance and support throughout the course of this research. They were always there when I had any doubts or questions and this thesis report is a result of constant motivation and direction I received from them.

I also would also like to thank my family for their endless love and support throughout the course of my graduate degree.

NOMENCLATURE

A/E/C	Architecture Engineering Construction
ANOVA	Analysis of Variance
BLS	Bureau of Labor Statistics
CPI	Consumer Price Index
PRESS	Predicted Error Sum of Square
SSE	Sum of Square of Errors

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1. INTRODUCTION

1.1 Background

Construction Industry is one of the largest sectors in United States. Due to the sheer volume of the industry, gross margin or profitability of construction industry plays an important role in the country's economy.

There has been very limited previous research on studying and quantifying gross margin and labor productivity. Further, there has not been any significant research on macroeconomic state-wise analysis of gross margin in construction industry using cluster analysis i.e understanding the factors affecting gross margin of construction industry at a state-wise level by grouping states with similar trends under clusters.

One of the biggest challenges that have prevented research in this field is the lack of reliable data. There is no state-wise data available for gross margin or labor productivity. However, the U.S Economic Census Reports published by U.S Census Bureau provide other pertinent data which can be used to compute gross margin, labor productivity and other important factors contributing gross margin at a state level. For this research, these factors were calculated for all the states in USA for the periods ending in 1997, 2002 and 2007.

An attempt was then made to analyze the data of the states in the form of clusters

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This thesis follows the style of *Journal of Construction Engineering and Management.*

having similar patterns. The idea behind this analysis was to broadly recognize clusters which can incorporate all the states based on their trends over the years. The study attempted to identify specific trends in some states; this was used in the process of grouping these states together. In doing so, trends of each state could be projected as a part of the cluster to which they belong. States were clustered using hierarchical clustering method by inputting all the parameters needed to define clusters.

The research proceeded in two phases; each phase focused on developing a unique model which helps in understanding, quantifying and predicting gross margin as a function of independent variables at a state-wise level. In the first model, an attempt was made to study the effect of as many independent variables which could be calculated from the census data available on gross margin. Six independent factors which seemed to be having an effect on gross margin were selected. The dependent variable was taken to be gross margin per establishment in each state. Next, cluster analysis was done to identify clusters having a specific pattern based on all the variables taken together. Finally, each cluster was analyzed independently to see which factors influence gross margin. Method of backward elimination was used to eliminate non-significant clusters. A predictive equation for each cluster was developed and validated.

The results of first model prompted in developing the second model. As per the first model, the single most crucial factor which contributed to gross margin was labor productivity. Second model was developed similarly with gross margin per construction worker being the dependent variable on labor productivity of construction worker.

Clusters were developed in similar manner and analyzed to develop regression model for each cluster.

For each of the model, an excel embedded decision-support tool was developed which gave a clear picture of all the states at a glance in the form of a color-coded map. The map was built as an interactive tool which can direct the user to toggle between any of the state for more information. The model was built so that there can be seamless integration when 2012 census data is available. The research would thus prove as a pilot project for further research once the 2012 census data is available. The predictability of the model would improve substantially as more data is available. The model would benefit contractors to gather pertinent information at a state-wise level and aid in their decision making.

1.2 Definition of Terms

Gross margin: The gross margin represents the percent of total sales revenue that the company retains after incurring the direct costs associated with producing the goods and services sold by a company (Investopedia 2011). For the study, gross margin is calculated as:

GM = Value added – (Total rental costs +capital expenditures, except land + Total annual payroll)

For each of the model, different versions of GM were used. For Model 1, Gross Margin per establishment was used whereas for Model 2, Gross Margin per construction worker was used.

Gross Margin per establishment = GM/Number of establishments in the state

Gross Margin per construction worker = GM/Number of construction worker in the state

Labor productivity: Bureau of Labor Statistics (BLS) defines Labor Productivity as "output to the labor hours used in the production of that output" (BLS 2011a). It is essentially the work completed per unit of labor. For the research, labor productivity is calculated as:

LP = Value of construction work / Average number of construction workers

Value of construction work: Value of construction work is defined by the U.S Census Bureau as the sum of all the value (in dollars) of construction work done by general contractors, as well as special, heavy, and special trade contractors, including new construction, additions, alterations, or reconstruction, and maintenance and repair of construction work (Census 2011a). The value of construction work is taken from the U.S census data for 1997, 2002 and 2007.

Construction worker wages per construction worker: Construction worker average wages is studied as one of the six dependent variables used in Model 1 of the research. It is calculated as:

Construction worker wages per construction worker: Total payroll of construction workers / Average number of construction workers for each state.

Percent of construction work sub-contracted: Percent of construction work sub-contracted is studied as one of the six dependent variables used in Model 1 of the research. It is calculated as:

% construction work S/C out: (Cost of construction work contracted out to others / Value of construction work) * 100

Percent use of rental equipment: Percent use of rental equipment is studied as one of the six dependent variables used in Model 1 of the research. It is calculated as:

% Rental Equipment: (Cost of rental equipment / Value of construction work) * 100

Percent of labor cost: Percent labor cost is studied as one of the six dependent variables used in Model 1 of the research. It is calculated as:

% Labor Cost: (Labor Cost / Value of construction work) * 100

Percent of cost of materials, components and supplies: Percent cost of materials, components and supplies is studied as one of the six dependent variables used in Model 1 of the research. It is calculated as:

% cost of materials, components and supplies: (cost of materials, components and supplies / Value of construction work) * 100

Consumer price index: The Consumer Price Index (CPI) is used as a measure to calculate change in dollar amounts of a particular year and adjust that change to get actual value of that amount in the current year. In other words, it is a measure of inflation (BLS 2010).

2. RESEARCH SCOPE AND SIGNIFICANCE

2.1 Problem Statement

Labor productivity and gross margin in construction industry are very important factors which not only affect the construction industry but the economy of USA as a whole. According to Architecture, Engineering and Construction (A/E/C) industry experts, one of the most critical problems in improving productivity of the construction industry is that no reliable labor productivity data for the industry exists (Tuchman 2003). Lack of reliable is the major reason why there is not much research in this field. There is no significant research conducted at the state-wise analysis of labor productivity and other pertinent factors and how they influence gross margin in the construction industry.

2.2 Research Objectives

The objectives of the research are:

1. Analyzing state-wise trends of profitability (gross margin) in the construction industry in USA.
2. Studying the factors which influence gross margin in the construction industry.
3. Developing a regression model for each of the two models proposed in the research at cluster level.

4. Developing an interactive decision support tool in the form of maps which are color-coded both by states and clusters to reflect the gross margin and labor productivity in all the states.

2.3 Research Hypotheses

Following hypotheses drive the research:

1. Relationship exists between gross margin and independent variables including labor productivity, percent of construction work sub contracted out, construction worker wages per construction worker, percent use of rental equipment, percent of labor cost and percent of materials, components and supplies. A model described below is possible for each of the clusters encompassing all the states:

   GM = β_0 +β_1*LP + β_2*Wage/Worker + β_3*S/C% + β_4*Rental% + β_5*Labor Cost% + β_6*Material, Comp & Supp %

2. Positive relationship exists between gross margin and labor productivity. A model described below is possible for each of the clusters including all the states:

   GM = β_0 +β_1*LP

2.4 Limitations of the Research

1. The research analyzes gross margin at a state level only, thus lacking details by not researching at the county level or sub-sector level within the construction industry.

2. Lack of up-to date data is another limitation of this study. The study is based on the data made available by Census Bureau from 1997 (covering years 1993-1997), 2002 (covering years 1998 to 2002) and 2007(covering years 2003-2007). Data after 2007 is not available as of now. Therefore, the models proposed by the research do not include the most recent data.

2.5 Research Significance

The research will be the first of its kind in construction industry to study the pertinent factors affecting construction industry's profitability at a state-level using cluster analysis. Research will develop a predictive model to determine gross margin as a function of important significant factors. Second model of the research will provide predictive model of gross margin as a function of labor productivity for each cluster covering all the states.

The research will thus provide a tool to gauge the trends and patterns of gross margin across all the states in the construction industry. The decision support tool developed in the research will provide a visual understanding of labor productivity and gross margin at a glance. Further, clustering the states will help to identify the patterns which exist among the states. Thus, by breaking down the diverse geography of USA into clusters of states, gross margin can be predicted more accurately. Study will also provide ground work for further developing this model as 2012 census data is made available. The model developed can also be extended to various sub-sectors in the construction industry and at a county level within the states.

3. LITERATURE REVIEW

Literature review aims to cover a few studies which strive to quantify labor productivity and develop predictive models. However, there has not been any research where state-wise prediction modeling is attempted using cluster analysis. Therefore, the literature review for the research was a challenging task due to lack of pertinent studies in the past which fits within the research scope of this study.

Lack of data has not attracted much research in this area. Studies related to the accurate measurement of the productivity of the construction industry have been limited (BFC 2006). Construction productivity is a critical factor which determines the performance of construction industry.

3.1 Quantifying Labor Productivity

Quantifying labor productivity and other factors affecting gross margin of construction industry is the most important step towards understanding and improving profitability of the construction industry. Construction industry is a labor oriented industry and employed 7.3 million workers from 2002-2007 (Census 2011a). The labor cost is somewhere between 20% and 50% of the total project cost (Buchan 1993; Kaming et al. 1998; Zakeri et al. 1997) and the reduction of these costs can be best carried out by improving productivity (Kaming et al. 1998).There have been many research efforts to examine productivity measurement and consequently contribute to the better productivity management (Heap and Office 1987; Herbsman and Ellis 1990;

Thomas and Završki 1999). However, there have been no conclusive results about construction labor productivity. For example, in one of the studies, it was found that construction industry has declined from 1968 to 1978 and regarded the shift in the output between commercial projects to residential projects as the contributing factor (Allen 1985). However, another independent study found that the productivity has increased from 1980 to 1990 due to depressed real wages and technological advances (Allmon et al. 2000). Although many studies have been attempted to measure the performance of the construction industry but there exist no reliable data which confirms that the productivity has either increased or decreased for both construction industry. (Chapman and Butry 2008). Researchers have not been able to establish a trend in construction productivity over the last few years.

One of the studies focused on critically examining the macroeconomic labor productivity data in the U.S from 1979 to 1998 to test its validity (Rojas and Aramvareekul 2003). The formula used in the study for labor productivity was:

$$\mathbf{P = GPO / (\sum E*H)}$$

Where:

P: Labor Productivity

GPO: gross product originating, by industry

E: Average number of employees

H: Average number of hours per employee

This was calculated for each industry for every month. Data was collected from BLS (Bureau of Labor Statistics) and BEA (Bureau of Economic Census) (Rojas and

Aramvareekul 2003). The construction industry was then divided into two groups: Residential and commercial construction and Non-residential and heavy construction (Rojas and Aramvareekul 2003). An output mix was generated, which represented the percentage of participation of a particular sector in the industry (Rojas and Aramvareekul 2003). Some of the interesting conclusions of the study which are relevant to the research were:

1. The paper uncovered several problems with regard to the reliability and validity of construction labor productivity values calculated from macroeconomic data for the 1979–1998 period. These problems include deficiencies in data collection, data processing, and interpretation of results. (Rojas and Aramvareekul 2003)
2. GPO is calculated based on project rather than establishment data, generating less reliable data than those obtained for the manufacturing industry. (Rojas and Aramvareekul 2003)
3. The inability to differentiate between the diverse sectors of the construction industry in a changing output mix environment may have created misinterpretations of labor productivity values, as sectors with low productivity have increased their share of the market. (Rojas and Aramvareekul 2003)

Another study was conducted in year 2000 to understand trends in labor productivity in construction industry over the past 25-30 years (Allmon et al. 2000). The data was collected from Means' Cost Manual and was adjusted using Consumer Price Index (CPI) (Allmon et al. 2000). Six kinds of tasks including framing productivity in housing construction, web joist productivity in Commercial construction, welded steel pipe, acoustic ceiling tiles, compaction productivity in heavy construction and hand trenching were selected with an intention to cover a variety of trades within building construction sector (Allmon et al. 2000). Fourteen randomly selected activities were also studied to observe productivity changes (Allmon et al. 2000). Main conclusion of the study was that the labor productivity decreased during 1970's but increased between 1980's and 1990's. The main reasons for the same were depressed real wages and technological advancements (Allmon et al. 2000).

3.2 Productivity Prediction Modeling

Construction productivity is traditionally identified as one of the three main critical success factors together with cost and quality for a construction project (Nkado 1995; Walker 1995). The assignment decisions of resources such as labor, equipment and material control the overall duration and cost of a project (Hegazy 1999). There have been studies in the past to identify factors contributing to labor productivity and to develop predictive model which helps understanding labor productivity. Various models have been developed for the estimation of labor productivity but they do not provide reliable and accurate results, because of lack of valid and reliable information on production rates (Muqeem et al. 2011). Many prediction modeling techniques have been used through a decade such as statistical model, action response model, factor model, linear regression model etc. (Oduba and Fayek (2005).

In one of the studies, an attempt was made to develop a model to evaluate labor productivity (Pace 1994). Research showed that contrary to popular belief, factors such as adverse weather, schedule overtime and material shortages do not necessarily lead to a loss of productivity (Pace 1994). Also, the extent of productivity losses varied from project to project, activity to activity and crew to crew (Pace 1994). The action-response model developed in the research aimed to identify these processes and factors (Pace 1994). The model graphically depicted how a variety of factors may interact to cause loss of productivity (Pace 1994). The model could be used as a guideline by management to mitigate these factors and improve labor productivity (Pace 1994).

Other important study conducted in 2009 aimed to model the variability of masonry labor productivity (Sweis et al. 2009). This was achieved by analyzing a database consisting of 14 masonry projects to present the theoretical basis of baseline productivity measurements (Sweis et al. 2009). After the baseline productivity was defined, two major categories of variables that influence labor productivity were introduced:

1. Nature of work to be done
2. Work environment factors

A Work Content (WC) scale for the selected construction activity was proposed. Work content was defined as a non-mathematical term referring to the complexity of the design, where the integers from 5 to 1 represent activity complexity in descending order (5 being the most complex, 1 the least complex) (Sweis et al. 2009).

The daily productivity was defined as the work hours per unit of work. It was based on the equivalent quantities and was calculated as follows:

Daily Productivity = Work Hours / Equivalent Quantities

The theory underlying the masonry labor productivity model was that in general the work of a crew is affected by a number of factors that might lead to a loss in potential productivity (Sweis et al. 2009).

The research compared labor productivity with respect to baseline productivity (Sweis et al. 2009). Authors defined baseline productivity as the best productivity value that a contractor can achieve on a particular project in a case where there are few or no disruptions (Sweis et al. 2009). The research proposed a framework for developing a method to model the variability of masonry labor productivity (Sweis et al. 2009). Single project was evaluated by using various project attributes extracted from the data. One of the scopes of future research as per the authors of this research was to develop a multiple regression model to quantify the influence of work environment factors (Sweis et al. 2009).

4. RESEARCH METHODS

4.1 Data Collection

All the data for the research were collected from U.S Economic Census reports of 1997, 2002 and 2007. Census Bureau generates the U.S. Economic Census reports every five years and provides a detailed description on the local, regional, and national level covering all the sectors of the U.S economy. The reports were used to extract the following relevant information of the construction industry.

1. State
2. Average number of construction workers
3. Number of establishments
4. Value of construction work (in $1,000)
5. Value added (in $1,000)
6. Cost of materials, components, and supplies (in $1,000)
7. Cost of construction work subcontracted out to others (in $1,000)
8. Total rental costs (in $1,000)
9. Capital expenditures, except land (in $1,000)
10. Total annual payroll (in $1,000)

Each of these values was used directly as variables or indirectly to calculate variables used in the research.

4.2 Missing Values in the Data

Some of the values in 1997 census report were missing for either of the following reasons:

1. Sampling error exceeded 40 percent.
2. Withheld to avoid disclosing data of individual companies.
3. Withheld because estimates did not meet publication standards.

Therefore, some of the values from 1997 reports were eliminated from analysis to avoid outliers and miscalculation of values in the analysis.

4.3 Adjusting the Values Based on Consumer Price Indexing (CPI)

Inflation is an important parameter in macroeconomic studies because it is considered as an indicator of economy (BLS 2011b). The purpose of using inflation as a factor in the research was to be able to compare costs from 1997, 2002 and 2007 reports in the analysis. This was possible only when there was a common unit for all the costs. Using Inflation Calculator (BLS 2011c) provided by Bureau of Labor Statistics, costs from 1997 and 2002 reports were adjusted to reflect dollar amount as per 2007. Therefore, all costs had a common unit which was 2007 dollar value.

4.4 Cluster Analysis

The research focused on finding any similar patterns which may exist in states based on various variables. For both the models, Hierarchical cluster method was used to divide the states into clusters and three clusters were formed using this method for each model.

In model 1, following variables were used to divide the states into clusters:

1. Gross margin per establishment
2. Labor productivity
3. Construction worker wages per construction worker
4. Percent of construction work sub-contracted out
5. Percent use of rental Equipment
6. Percent of labor Cost
7. Percent cost of materials, components and supplies

Following clusters were formed based on these variables as shown in Table 1:

Table 1: Clustering Results for Model 1

Cluster #1	Cluster # 2	Cluster # 3
Alabama (AL)	Alaska (AK)	Arizona (AZ)
Arkansas (AR)	California (CA)	Colorado (CO)
Delaware (DE)	Connecticut (CT)	District of Columbia (DC)
Idaho (ID)	Hawaii (HI)	Florida (FL)
Iowa (IA)	Illinois (IL)	Georgia (GA)
Kansas (KS)	Indiana (IN)	Maryland (MD)
Kentucky (KY)	Massachusetts (MA)	Missouri (MO)
Louisiana (LA)	Michigan (MI)	New Mexico (NM)
Maine (ME)	Minnesota (MN)	Tennessee (TN)
Mississippi (MS)	Nevada (NV)	Texas (TX)
Montana (MT)	New Hampshire (NH)	Virginia (VA)
Nebraska (NE)	New Jersey (NJ)	West Virginia (WV)
North Carolina (NC)	New York (NY)	
North Dakota (ND)	Ohio (OH)	
Oklahoma (OK)	Oregon (OR)	
South Carolina (SC)	Pennsylvania (PA)	
South Dakota (SD)	Rhode Island (RI)	
Utah (UT)	Washington (WA)	
Vermont (VT)	Wisconsin (WI)	
Wyoming (WY)		

The clusters are shown on a map in figure 1:

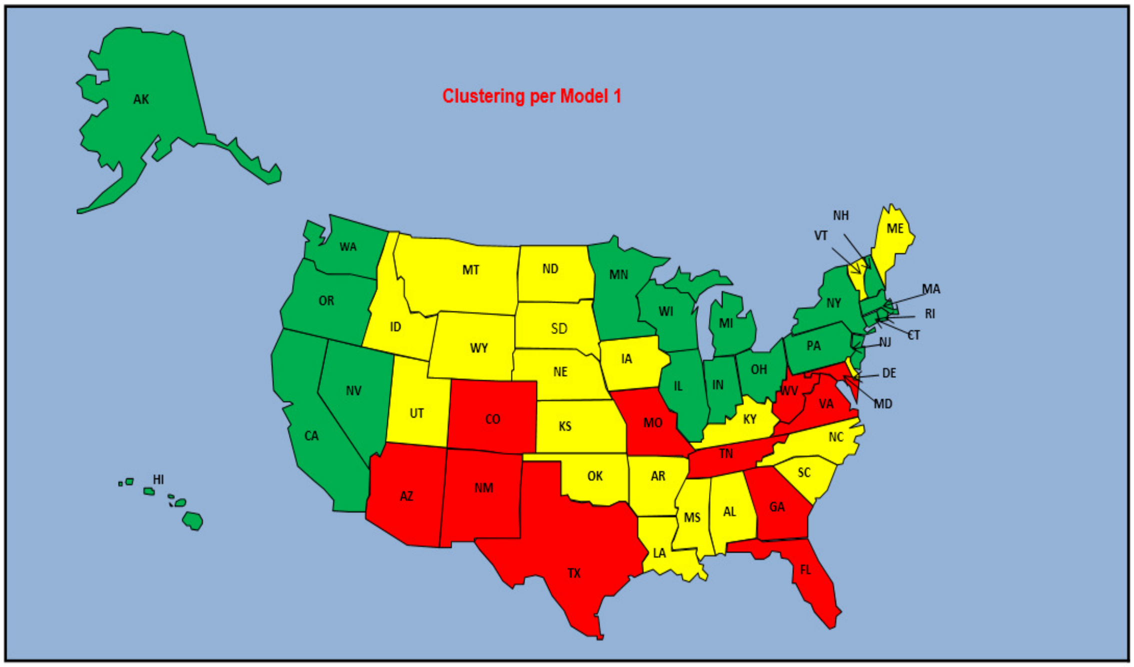

Figure 1: Map Showing Clustering Results for Model 1

Legend:

Color	Cluster #
(yellow)	Cluster 1
(green)	Cluster 2
(red)	Cluster 3

For model 2, only two variables - Gross Margin per number of workers (dependent variable) and Labor Productivity (independent variable) were used for cluster analysis. Based on these two variables, following clusters were formed as shown in table 2. By plotting Average gross margin by Average labor productivity, it can be observed that clusters can be easily discerned as shown in figure 2.

Table 2: Clustering Results for Model 2

Cluster # 1	Cluster # 2	Cluster # 3
Alabama (AL)	Arkansas (AR)	Alaska (AK)
Arizona (AZ)	Delaware (DE)	California (CA)
Colorado (CO)	Idaho (ID)	Connecticut (CT)
Michigan (MI)	Indiana (IN)	District of Columbia (DC)
North Carolina (NC)	Iowa (IA)	Florida (FL)
Ohio (OH)	Kansas (KS)	Georgia (GA)
Oregon (OR)	Kentucky (KY)	Hawaii (HI)
Pennsylvania (PA)	Louisiana (LA)	Illinois (IL)
Texas (TX)	Maine (ME)	Massachusetts (MA)
Utah (UT)	Maryland (MD)	Minnesota (MN)
Washington (WA)	Mississippi (MS)	Nevada (NV)
Wisconsin (WI)	Missouri (MI)	New Jersey (NJ)
	Montana (MT)	New York (NY)
	Nebraska (NE)	Rhode Island (RI)
	New Hampshire (NH)	
	New Mexico (NM)	
	North Dakota (ND)	
	Oklahoma (OK)	
	South Carolina (SC)	
	South Dakota (SD)	
	Tennessee (TN)	
	Vermont (VT)	
	Virginia (VA)	
	West Virginia (WV)	
	Wyoming (WY)	

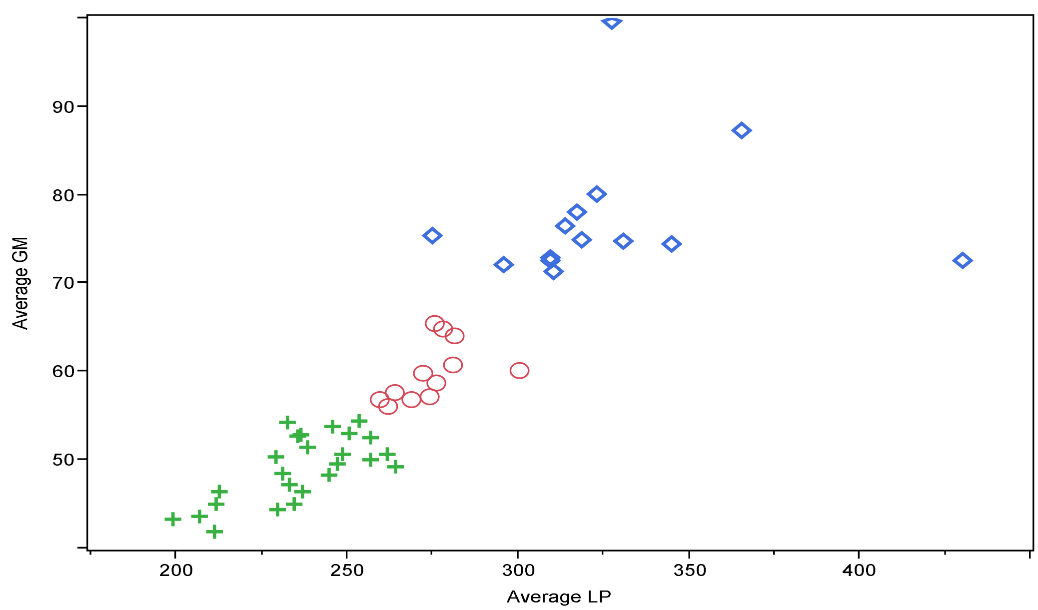

Figure 2: Scatterplot for Average Labor Productivity vs. Average Gross Margin for Model 2.

For the sake of better understanding, the clusters were named as follows:

Cluster 1: (O) Average LP and GM

Cluster 2 (+) Low LP and GM

Cluster 3 (◊) High LP and GM

The clusters are shown on the map in figure 3.

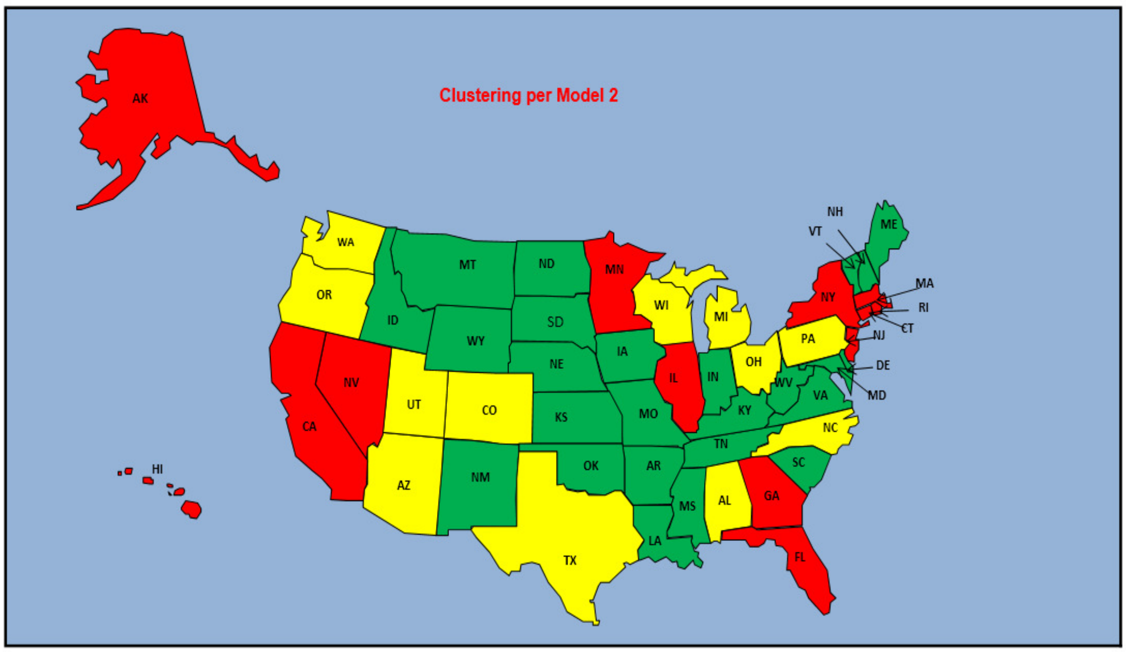

Figure 3: Map Showing Clustering Results for Model 2

Legend:

Color	Cluster #	Definition
	Cluster 1	States with Average LP, GM
	Cluster 2	States with Low LP, GM
	Cluster 3	States with high LP, GM

4.5 Statistical Analysis

Each cluster in both the models was analyzed separately to study the effect of independent variables on Gross Margin. For model 1, gross margin per establishment was considered as the dependent variable while for Model 2, gross margin per construction worker was considered as dependent variable. Analysis of variance (ANOVA) was performed to test for relationships between independent and dependent variables. R-square values and p-values were used to test the soundness of the model. PRESS values were used to validate the predictability of the model. The Predicted Error Sum of Square (PRESS) statistic is one of the most commonly used and preferred validation alternatives because it clearly indicates the predictability and accuracy of the model (Ott and Longnecker 2000). For model 1, method of backward elimination was used to eliminate non-significant variables. Using this method, first all independent variables were taken into consideration and ANOVA was performed. Next, the most insignificant variable based on p-value was taken out. It was ensured that the exclusion does not have a significant effect on R-square of the overall model. The process was continued until all significant variables are left. For the research, p-values of less than 0.05 were taken as significant.

4.6 Decision Support Tool

Excel-embedded decision support tool which consisted of color-coded maps was developed to aid the better understanding of gross margin and labor productivity trends. Maps were developed on Excel worksheets so that they could pull data directly from the main database file. The maps were made so that they could be easily toggled based on the range of data selected. Maps were color-coded based on the gross margin/labor productivity of every state. Darker shades represented higher values of gross margin/ labor productivity. Same model was also used to show clusters for Model 1 and Model 2. Maps were linked to the database such that there could be seamless integration when the census 2012 data is made available.

5. RESULTS AND INTERPRETATION

5.1 Model 1

Model 1 focused on identifying pertinent variables which affect gross margin. Following independent variables were studied against the dependent variable of gross margin per establishment:

1. Labor Productivity (LP)
2. Construction worker wages per construction worker (Wage/Worker)
3. Percent of construction work sub-contracted (S/C%)
4. Percent use of rental equipment (Rental %)
5. Percent of labor cost (Labor Cost %)
6. Percent of cost of materials, components and supplies (Material, Comp & Supp %)

Since different variables could affect different group of states, all the states were clustered into three groups based on the above mentioned variables using Hierarchical clustering method. Step-wise backward elimination method was used to eliminate non-significant independent variables. Using this method, for each cluster, all the independent variables were included in the first step of ANOVA analysis. Non-significant variables were eliminated at each step. Finally, a model was developed which gave a predictive equation of gross margin as a function of all significant variables. Following results were observed for each cluster:

5.1.1 Cluster – 1

States included in cluster 1 are shown in table 1 and on the US map in figure 1

Following are the steps of backward elimination process for cluster 1 shown in table 3. The eliminated variable is highlighted for each step.

Table 3: Backward Elimination Steps for Cluster 1

Step - 1				
Summary of Fit Results				
R square			0.39369	
R square adj			0.312849	
Root Mean Square Error			86.62418	
Mean of Response			333.4846	
Observations			52	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	6	219255.39	36542.6	4.8699
Error	45	337668.7	7503.7	**Prof > F**
C. Total	51	556924.09		0.0007*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		43231.329	5.7613	0.0206*
Wage/Worker		21768.537	2.901	0.0954
S/C %		36837.941	4.9093	0.0318*
Rental %		1262.189	0.1682	0.6837
Labor Cost %		24637.51	3.2834	0.0767
Material, Comp & Supp %		87.685	0.0117	0.9144

Step - 2				
Summary of Fit Results				
R square			0.393532	
R square adj			0.327612	
Root Mean Square Error			85.68856	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	5	219167.7	43833.5	5.9698
Error	46	337756.38	7342.5	**Prof > F**
C. Total	51	556924.09		0.0002*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		43467.658	5.92	0.0189*
Wage/Worker		21691.437	2.9542	0.0924
S/C %		38289.972	5.2148	0.0271*
Rental %		1837.743	0.2503	0.6193
Labor Cost %		25461.54	3.4677	0.069

Table 3: Continued

Step - 3				
Summary of Fit Results				
R square			0.390233	
R square adj			0.338338	
Root Mean Square Error			85.00239	
ANOVA Results				
`Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	4	217329.96	54332.5	7.5196
Error	47	339594.13	7225.4	**Prob > F**
C. Total	51	556924.09		<.0001*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		44366.512	6.1403	0.0169*
Wage/Worker		23325.618	3.2283	0.0788
S/C %		42556.29	5.8898	0.0191*
Labor Cost %		25120.066	3.4766	0.0685
Step - 4				
Summary of Fit Results				
R square			0.34835	
R square adj			0.307622	
Root Mean Square Error			86.95302	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	3	194004.34	64668.1	8.553
Error	48	362919.74	7560.8	**Prob > F**
C. Total	51	556924.09		0.0001*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		41129.572	5.4398	0.0239*
S/C %		54339.798	7.187	0.0100*
Labor Cost %		1947.09	0.2575	0.6142

First step of analysis was conducted by including all the independent variables. As it can be observed from step 1, the variable, “Percent of cost of materials, components and supplies” had the highest p-value. Hence, it was eliminated from the list of independent variables and ANOVA analysis was re-run excluding the variable.

Following the same logic as in step 1, independent variable “Percent use of rental equipment”, having the highest p-value was excluded from further analysis and step 3 of ANOVA was performed using the remaining variables.

Independent variables "Construction worker wages per construction worker" and "Percent of labor cost" were eliminated after step 3 and 4 respectively.

The final results of cluster 1 are shown in table 4.

Table 4: Final Model Results for Cluster 1

Step - 5 Final Model				
Summary of Fit Results				
R square			0.344854	
R square adj			0.318113	
Root Mean Square Error			86.29173	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	2	192057.25	96028.6	12.8962
Error	49	364866.83	7446.3	**Prob > F**
C. Total	51	556924.09		<.0001*
Parameter Estimates Results				
Source	**Estimate**	**Std. Error**	**t Ratio**	**Prob > |t|**
Intercept	356.25034	131.509	2.71	0.0093*
LP	1.2018324	0.361537	3.32	0.0017*
S/C %	-1311.475	380.8552	-3.44	0.0012*
PRESS Results				
PRESS		**PRESS RMSE**		
429769.611		90.911		

As it can be observed from table 4, all the remaining variables are significant having p-values of less than 0.05. Hence, the final model for cluster 1 can be deduced from the above analysis.

The final model for cluster 1 can be written as:

GM = 356.25034 + 1.2018324*LP - 13.11475* S/C%.

Where:

GM: Gross Margin per establishment

LP: Labor Productivity

S/C%: Percent of construction work sub-contracted out

Table 4 shows the PRESS values for cluster 1 analysis. PRESS values are used to validate the predictability of the model. PRESS/SSE (Sum of square of errors) equals 1.178 which indicates high predictability of the model.

Figure 4 shows the residual by predicted plot for cluster 1. There was no specific pattern in the residual plot which obviates the need to use any transformations for the analysis.

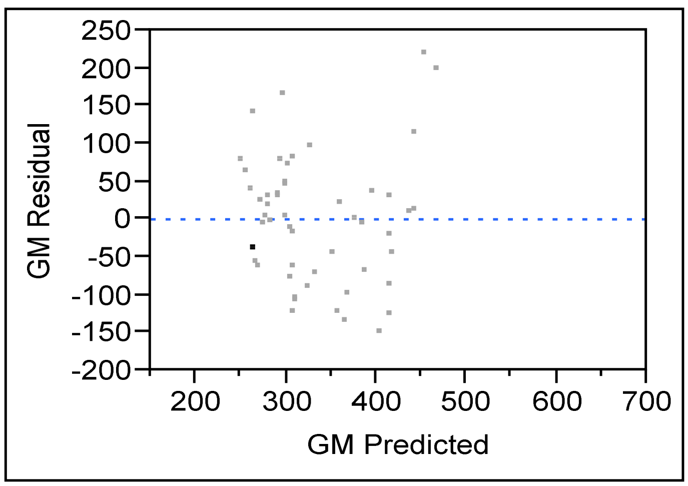

Figure 4: Model 1; Cluster 1; Step 5; Residual by Predicted Plot

5.1.2 Cluster – 2

States included in cluster 2 are shown in table 1 and on the US map in figure 1. Step-wise backward elimination on Cluster 2 is carried out in a similar way as done for Model 1. The results for Model 2 are shown below in table 5:

Table 5: Backward Elimination Steps for Cluster 2

Step - 1				
Summary of Fit Results				
R square			0.39487	
R square adj			0.31549	
Root Mean Square Error			177.203	
Mean of Response			470.0915	
Observations			53	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	6	942551.8	157092	5.0028
Error	46	1444441.1	31401	**Prob > F**
C. Total	52	2386992.9		0.0005*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		106972.91	3.4067	0.0714
Wage/Worker		96238.25	3.0648	0.0867
S/C %		26017.42	0.8286	0.3674
Rental %		489425.37	15.5864	0.0003*
Labor Cost %		54970.03	1.7506	0.1923
Material, Comp & Supp %		34390.28	1.0952	0.3008
Step - 2				
Summary of Fit Results				
R square			0.38397	
R square adj			0.318435	
Root Mean Square Error			176.8795	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	5	916534.4	183307	5.859
Error	47	1470458.5	31286	**Prob > F**
C. Total	52	2386992.9		0.0003*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		123236.56	3.939	0.053
Wage/Worker		102845.82	3.2872	0.0762
Rental %		483010.28	15.4384	0.0003*
Labor Cost %		68159.79	2.1786	0.1466
Material, Comp & Supp %		114282.36	3.6528	0.0621
Step - 3				
Summary of Fit Results				
R square			0.355416	
R square adj			0.3017	
Root Mean Square Error			179.0378	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	4	848374.6	212094	6.6166
Error	48	1538618.3	32055	**Prob > F**
C. Total	52	2386992.9		0.0003*

Table 5: Continued

Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		323352.38	10.0876	0.0026*
Wage/Worker		91411.93	2.8518	0.0978
Rental %		414982.14	12.9461	0.0008*
Material, Comp & Supp %		91490.44	2.8542	0.0976
Step - 4				
Summary of Fit Results				
R square			0.31712	
R square adj			0.275311	
Root Mean Square Error			182.3895	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	3	756962.7	252321	7.585
Error	49	1630030.2	33266	**Prob > F**
C. Total	52	2386992.9		0.0003*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		454607.65	13.6659	0.0006*
Rental %		352282.11	10.5899	0.0021*
Material, Comp & Supp %		114564.24	3.4439	0.0695

Final step for cluster 2 is shown in table 6 below:

Table 6: Final Model Results for Cluster 2

Step - 5 Final Model				
Summary of Fit Results				
R square			0.2629125	
R square adj			0.23989	
Root Mean Square Error			186.7937	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	2	642398.5	321199	9.2056
Error	50	1744594.5	34892	**Prob > F**
C. Total	52	2386992.9		0.0004*
Parameter Estimates Results				
Source	**Estimate**	**Std. Error**	**t Ratio**	**Prob > |t|**
Intercept	-655.8518	272.4425	-2.41	0.0198*
LP	1.9863803	0.527236	3.77	0.0004*
Rental %	34665.788	12258.52	2.83	0.0067*
PRESS Results				
PRESS		**PRESS RMSE**		
2069033.926		197.581		

Final model for cluster 2 can be deduced from the above analysis.

The final model for cluster 2 can be written as:

GM = -655.8518 + 1.9863803*LP + 346.65788*Rental%

Where:

GM: Gross Margin per establishment

LP: Labor Productivity

Rental%: Percent use of rental equipment

Figure 5 shows the residual by predicted plot for cluster 2. There was no specific pattern observed in the residual plot which indicated no need to use any transformations for the analysis.

Table 6 shows the PRESS value for cluster 2. PRESS/SSE equals 1.186 which indicates high predictability of the model.

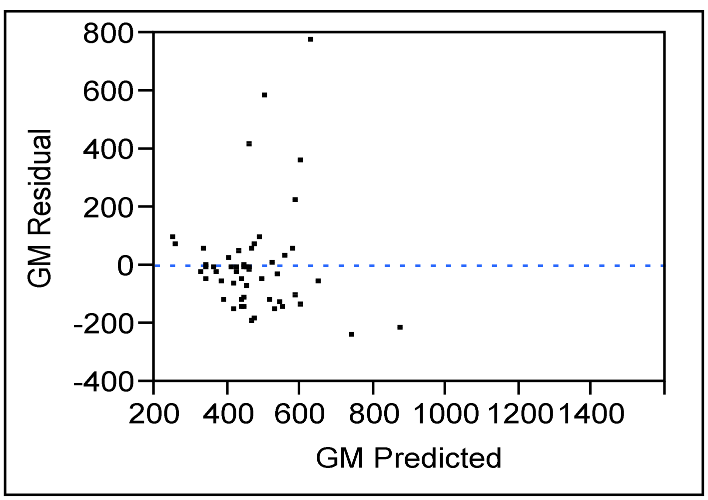

Figure 5: Model 1; Cluster 2; Step 5; Residual by Predicted Plot

5.1.3 Cluster – 3

States included in cluster 3 are shown in table 1 and on the US map in figure 1. Cluster 3 was also analyzed in the same way as cluster 1 and 2. Results of backward elimination for cluster 3 are shown as below in table 7:

Table 7: Backward Elimination Steps for Cluster 3

Summary of Fit Results				
R square			0.681751	
R square adj			0.608309	
Root Mean Square Error			126.7851	
Mean of Response			495.7315	
Observations			33	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	6	895299.6	149217	9.2828
Error	26	417936.3	16074	**Prob > F**
C. Total	32	1313235.8		<.0001*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		32328.813	2.0112	0.168
Wage/Worker		814.838	0.0507	0.8236
S/C %		98291.035	6.1147	0.0203*
Rental %		2865.855	0.1783	0.6763
Labor Cost %		763.497	0.0475	0.8292
Material, Comp & Supp %		73232.836	4.5558	0.0424*
Step - 2				
Summary of Fit Results				
R square			0.681169	
R square adj			0.622127	
Root Mean Square Error			124.5287	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	5	894536.1	178907	11.5369
Error	27	418699.8	15507	**Prob > F**
C. Total	32	1313235.8		<.0001*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		377969.03	24.3735	<.0001*
Wage/Worker		13137.99	0.8472	0.3655
S/C %		100096.23	6.4547	0.0171*
Rental %		2553.31	0.1647	0.6881
Material, Comp & Supp %		83076.55	5.3572	0.0285*
Step - 3				
Summary of Fit Results				
R square			0.679225	
R square adj			0.6334	
Root Mean Square Error			122.6571	

Table 7: Continued

ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	4	891982.7	222996	14.8222
Error	28	421253.1	15045	**Prob > F**
C. Total	32	1313235.8		<.0001*
Effect Test Results				
Source		**Sum of Squares**	**F Ratio**	**Prob > F**
LP		486156.55	32.314	<.0001*
Wage/Worker		10966.32	0.7289	0.4005
S/C %		115748.78	7.6936	0.0098*
Material, Comp & Supp %		83365.21	5.5411	0.0258*

The results of final step for cluster 3 are shown in table 8 below:

Table 8: Final Model Results for Cluster 3

Step - 4 Final Model				
Summary of Fit Results				
R square			0.670875	
R square adj			0.636827	
Root Mean Square Error			122.0824	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	3	881016.4	293672	19.7041
Error	29	432219.4	14904	**Prob > F**
C. Total	32	1313235.8		<.0001*
Parameter Estimates Results				
Source	**Estimate**	**Std. Error**	**t Ratio**	**Prob > |t|**
Intercept	253.69656	166.6078	1.52	0.1387
LP	2.5747574	0.354657	7.26	<.0001*
S/C %	-576.7846	214.0089	-2.7	0.0116*
Material, Comp & Supp %	-1099.451	496.288	-2.22	0.0347*
PRESS Results				
PRESS		**PRESS RMSE**		
565462.401		130.902		

Table 8 shows that there are three significant variables for cluster 3. From the final analysis, the prediction equation for Gross Margin per establishment can be written as shown below:

GM = 253.69556 + 2.5747574*LP - 576.7846*S/C% - 1099.451* Material, Comp & Supp%

Where:

GM:	Gross Margin per establishment
LP:	Labor Productivity
S/C%:	Percent of construction work sub-contracted out
Material, Comp & Supp %:	Percent of cost of materials, components and supplies

Table 8 shows the PRESS value for cluster 3. PRESS/SSE equals 1.308 which indicates high predictability of the model. Figure 6 shows the residual by predicted plot for cluster 3. There is no specific pattern observed in the residual plot.

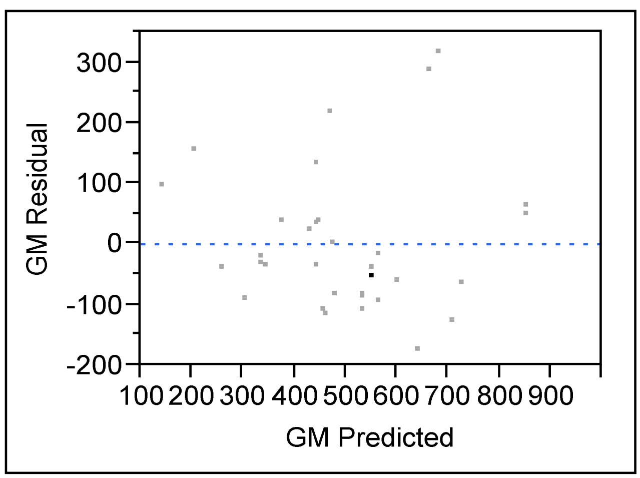

Figure 6: Model 1; Cluster 3; Step 4; Residual by Predicted Plot

5.1.4 Model -1 Summary

Table 9 shows the summary of results for model 1. Cluster 1 and cluster 2 had two significant variables contributing to gross margin whereas cluster 3 had three such variables. All these variables provide a sound model which can be used to predict the gross margin of any state based on the cluster to which it belongs. Low PRESS values for each of the cluster indicate high predictability of each model.

Table 9: Model 1 Summary of Results

Cluster #	Independent Variables	p-value	R-square	Prediction Expression	PRESS /SSE
1	Labor Productivity	0.0017	0.3448	GM = 356.250+1.202*LP-13.115*S/C%	1.178
	Percent of construction work sub-contracted	0.0012			
2	Labor Productivity	0.0004	0.239	GM = -655.852 +1.986*LP+346.66*Rental %	1.186
	Percent use of rental equipment	0.0067			
3	Labor Productivity	<0.0001	0.671	GM = 253.697+2.575*LP-5.768*SC -10.995*Mat%	1.308
	Percent of construction work sub-contracted	0.0116			
	Percent of cost of materials, components and supplies	0.0347			

From the table, it can be observed that labor productivity and percent use of rental equipment had a positive relation with gross margin. This means that increase in labor productivity increases gross margin which is understandable. Also, increase in rental equipment use increases gross margin of a construction firm. Probable reason for this observation could be that construction firms renting out construction equipment have higher short-term profits when compared to construction firms purchasing construction equipment. Since, construction equipment is very expensive, purchasing the equipment could show a drastic reduction of profits when viewed in a limited span of time.

From the table, it can also be observed that percent of construction work sub-contracted out and percent cost of materials, components and supplies had a negative relation with gross margin. Construction work sub-contracted out leads to lower gross margins. This can be explained by the fact that the profit margins of sub-contractors are deducted at every level, which reduces the profit margin of the prime contractor. Contractor with fewer subcontractors would thus have higher profits. Percent cost of materials, components and supplies also reduces the gross margin. Higher the percentage of total project cost is allocated to materials, components and supplies; lower is the margin for profit. This means projects which are less material-oriented would have higher profits.

Another interesting observation was that wages per construction worker and percent of labor cost did not have an effect on gross margin in any of the clusters. Also, the variable “labor productivity” was common in all the three clusters. This indicated that labor productivity is a very important factor which influences gross margin for any state. This result gave drive to the model 2 of the research where gross margin is studied as a function of only labor productivity.

5.2 Model – 2

Model 2 focused on establishing a relationship between gross margin and labor productivity. Reason for choosing only labor productivity as an independent variable is that previous model clearly showed that Labor Productivity is a single significant variable which is common in all the three clusters.

Cluster analysis was used again in Model 2. The purpose of using cluster analysis was to study the states in groups based on their Labor Productivity and Gross Margin. As seen in figure 2, performing hierarchical cluster analysis on the states based on Labor Productivity and Gross Margin clearly divided the states into three groups:

1. States with average Labor Productivity and Gross Margin (Cluster 1)
2. States with low Labor Productivity and Gross Margin (Cluster 2)
3. States with high Labor Productivity and Gross Margin (Cluster 3)

The dependent variable used in model 2 was "Gross Margin per construction worker." Following results were observed for each of the clusters.

5.2.1 Cluster – 1

States included in cluster 1 are shown in table 2 and on the US map in figure 3. As it can be observed from figure 2, cluster 1 includes states having average labor productivity and gross margin.

Table 10 shows the results observed for ANOVA analysis for cluster 1. Figure 7 shows the regression plot for cluster 1 analysis. Best fit line for the model was a linear line. Linear regression model was adopted for the model. R-square value for the model was 0.80977 which indicated strong relationship.

Table 10: Results for Cluster 1

Cluster - 1 Results				
Summary of Fit Results				
R square			0.80977	
R square adj			0.804006	
Root Mean Square Error			4.854598	
Mean of Response			59.82157	
Observations			35	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	1	3310.5757	3310.58	140.4743
Error	33	777.715	23.57	**Prob > F**
C. Total	34	4088.2907		<.0001*
Parameter Estimates Results				
Source	**Estimate**	**Std. Error**	**t Ratio**	**Prob > |t|**
Intercept	-14.54261	6.327732	-2.3	0.0280*
LP	0.2709628	0.022862	11.85	<.0001*
PRESS Results				
PRESS		**PRESS RMSE**		
971.981		5.27		

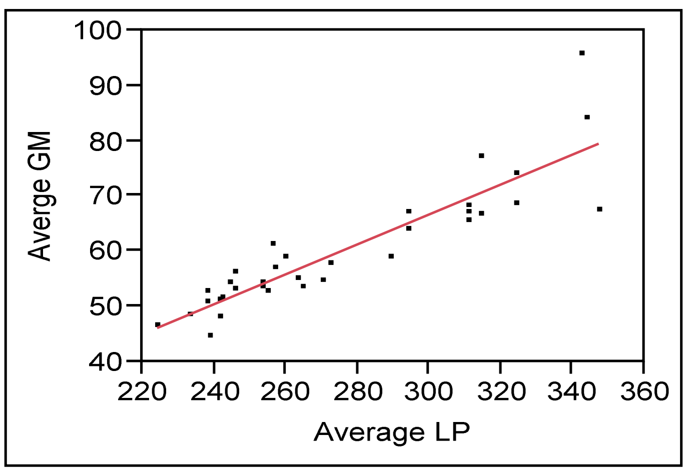

Figure 7: Model 2; Cluster 1; Regression Plot

From table 10, the predictive model for cluster 1 can be written as follows:

GM = -14.54261 + 0.2709628*LP

P-value of the analysis was found to be very low at <0.001 indicating high confidence value of the model. Figure 8 shows the residual by predicted plot. No specific patterns were found in the plot which indicated that no transformation was required.

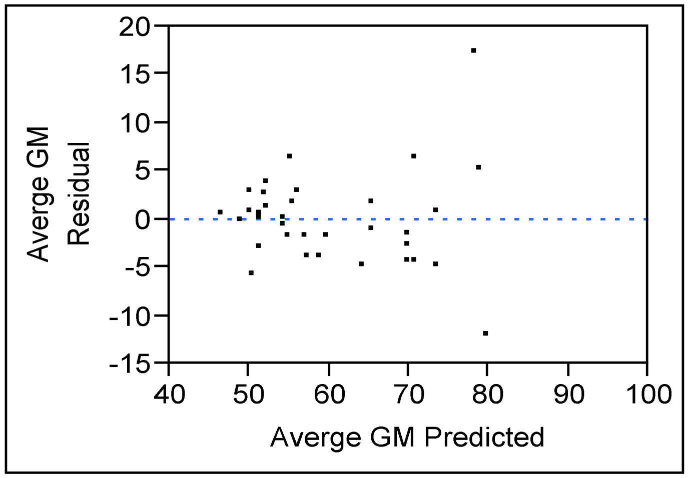

Figure 8: Model 2; Cluster 1; Residual by Predicted Plot

PRESS/SSE ratio for cluster 1 analysis was 1.2498 which means that the model had high predictability.

5.2.2 Cluster – 2

States included in cluster 2 are shown in table 2 and on the US map in figure 3. As it can be observed from figure 2, cluster 2 includes states having low labor productivity and gross margin.

Cluster 2 was analyzed similar to cluster 1. Linear model fitted the best in cluster 2 as well as can be observed from figure 9. R-square for linear regression model was 0.52067 meaning that 52% of the data perfectly fit the regression line. P-value of the analysis was low at < 0.001.

Following results were observed for ANOVA analysis for cluster 2:

Table 11: Results for Cluster 2

Cluster - 2 Results				
Summary of Fit Results				
R square			0.520607	
R square adj			0.513557	
Root Mean Square Error			5.962224	
Mean of Response			49.09141	
Observations			70	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	1	2625.0824	2625.08	73.8459
Error	68	2417.2718	35.55	**Prob > F**
C. Total	69	5042.3541		<.0001*
Parameter Estimates Results				
Source	**Estimate**	**Std. Error**	**t Ratio**	**Prob > |t|**
Intercept	7.2853861	4.916836	1.48	0.143
LP	0.1768749	0.020583	8.59	<.0001*
PRESS Results				
PRESS		**PRESS RMSE**		
2544.582		6.029		

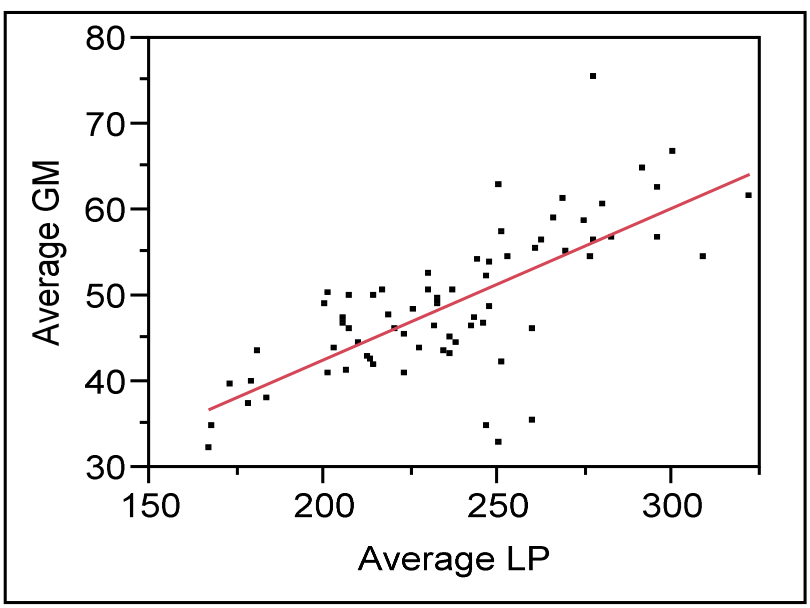

Figure 9: Model 2; Cluster 2; Regression Plot

From table 11, the predictive model for cluster 2 can be written as follows:

GM = 7.2853861 + 0.1768749*LP

No specific pattern was observed in the residual plot shown in figure 10, which indicated that there is no need to use any transformations. PRESS/SSE ratio for cluster 2 was found out to be 1.05267 which indicated high predictability of the model.

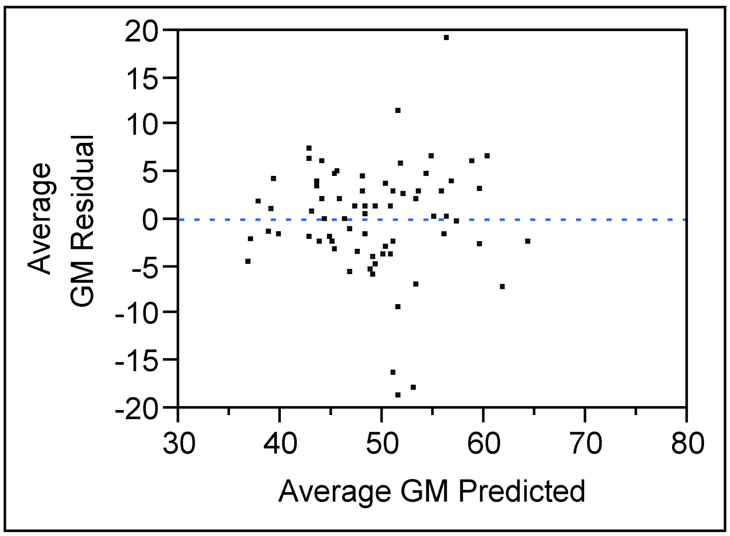

Figure 10: Model 2; Cluster 2; Residual by Predicted Plot

5.2.3 Cluster – 3

States included in cluster 3 are shown in table 2 and on the US map in figure 3. As it can be observed from figure 2, cluster 3 includes states having high labor productivity and gross margin.

Table 12 shows the results observed for ANOVA analysis for cluster 3:

Table 12: Results for Cluster 3

Cluster - 3 Results				
Summary of Fit Results				
R square			0.519648	
R square adj			0.506305	
Root Mean Square Error			12.92458	
Mean of Response			76.52145	
Observations			38	
ANOVA Results				
Source	**DF**	**Sum of Squares**	**Mean Square**	**F-ratio**
Model	1	6505.557	6505.56	38.945
Error	36	6013.608	167.04	**Prob > F**
C. Total	37	12519.164		<.0001*
Parameter Estimates Results				
Source	**Estimate**	**Std. Error**	**t Ratio**	**Prob > |t|**
Intercept	2.1776281	12.09603	0.18	0.8581
LP	0.2303667	0.036914	6.24	<.0001*
PRESS Results				
PRESS		**PRESS RMSE**		
7796.41		14.324		

Cluster 3 was also analyzed similarly. Regression plot can be seen in figure 11. R-square for linear regression model was 0.519648 meaning that 51.9% of the data perfectly fit the regression line. P-value of the analysis was low at < 0.001.

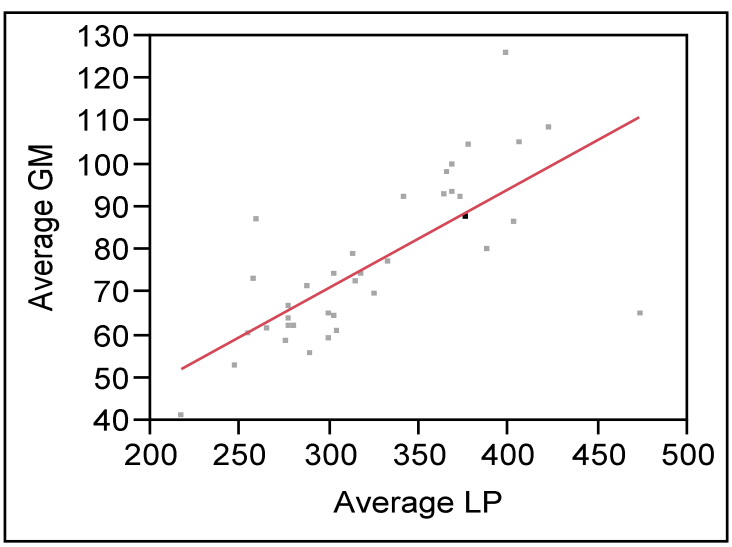

Figure 11: Model 2; Cluster 3; Regression Plot

From table 12, the predictive model for cluster 2 can be written as follows:

GM = 2.1776281+ 0.2303667*LP

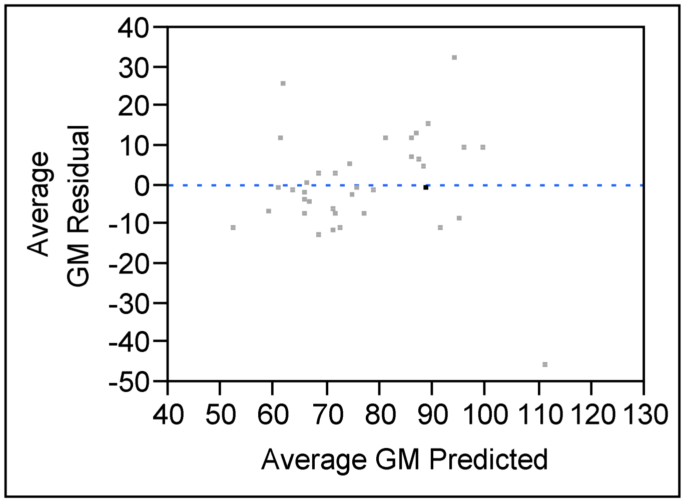

Figure 12: Model 2; Cluster 3; Residual by Predicted Plot

No specific pattern was observed in the residual plot shown in figure 12, which indicates that there is no need to use any transformations.

PRESS/SSE ratio for cluster 3 was found out to be 1.2965 indicating high predictability of the model.

5.2.4 Model – 2 Summary

Table 13 gives a summary of results for Model 2. In all the three clusters, labor productivity had a strong positive linear relation with gross margin. The R-square value suggests that predictive model for cluster 1 i.e. states with average labor productivity and gross margin has a better predictive power. The probable reason for this could be the lack of outliers for states with average labor productivity and gross margin which can be observed in figure 2. Overall, the model corroborates the findings of model 1 which suggested strong relationship between labor productivity and gross margin in all the states.

Table 13: Model 2 Summary of Results

Cluster #	p-value	R-square	Prediction Expression	PRESS RMSE/RMSE
1	<0.0001	0.81	GM = -14.543 + 0.271*LP	1.25
2	<0.0001	0.52	GM = 7.285 + 0.177*LP	1.05
3	<0.0001	0.52	GM = 2.178 + 0.230*LP	1.30

5.3 Decision Support Tool

Decision support tool in the form of color coded maps was developed using the calculated data for gross margin and labor productivity. The color-coding used in the map was such that darker shades represented a higher value of gross margin or labor productivity. Thus, one glance at the map gives a broad idea of how a particular state is performing compared to the other states.

Maps were made keeping in mind that they could be easily changed to reflect the changes in the data. Thus, it would be possible to analyze the trends for different year values. For example, analysis can be done for just 2003-2007 data or for just 1998-2007 data. Also, it would be very easy to incorporate 2012 U.S Census data once it becomes available.

Color codes were assigned to each state based on the value of labor productivity and gross margin. Then, these color codes were used to shade the particular state in the map. Ten values of color codes: 0 to 9 was used. Higher the gross margin/labor productivity value, higher the color code value and darker the shade. Color codes were computed as:

$$\mathbf{CC_i = (LP_i - LP_{min})*9/ (LP_{max}-LP_{min})}$$ or

$$\mathbf{CC_i = (GM_i - GM_{min})*9/ (GM_{max}-GM_{min})}$$

Where:

CC_i : Color Code for state “i”

LP_i : Labor Productivity for state “i”

LP_{min} : Labor Productivity of state having the lowest value of labor productivity

LP_{max} : Labor Productivity of state having the highest value of labor productivity

GM_i : Gross Margin for state “i”

GM_{min} : Gross Margin of state having the lowest value of gross margin

GM_{max} : Gross Margin of state having the highest value of gross margin

Tables 14, 15 and 16 show the color code values computed from the average values of gross margin or labor productivity from three census data reports. The values used are the average values over 15 years spanning 1993 – 2007. Corresponding maps are shown in figures 13, 14 and 15 below each table. Maps are color-coded based on the color code value from the table. Each state is linked to the color code value which defines its color.

Table 14: Data for Color Coding by Gross margin per Establishment

State	Gross Margin/establishment (CPI adjusted) Unit: $1000 2007 Value				
	1997	2002	2007	Average	Color Code Value
Alabama	-	405.677	558.955	482.316	3
Alaska	322.400	499.601	656.951	492.984	3
Arizona	411.416	578.455	996.007	661.959	5
Arkansas	299.019	269.303	380.492	316.271	2
California	445.293	579.063	805.954	610.103	5
Colorado	345.754	423.779	465.170	411.568	3
Connecticut	294.078	329.620	539.037	387.578	2
Delaware	225.479	421.641	446.674	364.598	2
District of Columbia	-	913.303	901.793	907.548	7
Florida	398.145	546.969	582.317	509.143	4
Georgia	467.486	494.208	660.600	540.764	4
Hawaii	-	586.630	955.502	771.066	6
Idaho	-	209.451	269.611	239.531	1
Illinois	406.869	478.337	587.666	490.958	3
Indiana	343.234	336.575	416.234	365.348	2
Iowa	258.732	244.164	371.795	291.564	1
Kansas	320.717	302.657	378.308	333.894	2
Kentucky	324.847	348.478	431.375	368.233	2
Louisiana	389.504	460.587	671.779	507.290	4
Maine	-	236.055	230.863	233.459	1
Maryland	359.397	474.628	539.867	457.964	3
Massachusetts	409.333	418.372	455.904	427.869	3
Michigan	326.817	354.453	393.167	358.146	2
Minnesota	383.076	394.502	640.886	472.822	3
Mississippi	327.590	376.510	663.797	455.965	3
Missouri	302.865	344.748	445.128	364.247	2
Montana	-	203.006	252.894	227.950	1
Nebraska	280.046	279.237	328.053	295.778	1
Nevada	1,088.328	873.838	1,399.277	1,120.481	9
New Hampshire	-	267.204	274.756	270.980	1
New Jersey	311.496	454.240	527.791	431.175	3
New Mexico	236.409	311.873	486.587	344.957	2
New York	-	428.546	523.168	475.857	3
North Carolina	297.559	344.257	455.694	365.837	2
North Dakota	-	306.253	319.571	312.912	2
Ohio	353.151	380.248	448.184	393.861	2
Oklahoma	291.037	295.214	376.793	321.015	2
Oregon	289.523	263.614	375.528	309.555	2

Table 14: Continued

State	Gross Margin/establishment (CPI adjusted) Unit: $1000 2007 Value				
	1997	2002	2007	Average	Color Code Value
Pennsylvania	339.685	435.741	441.817	405.748	3
Rhode Island	-	444.617	504.635	474.626	3
South Carolina	296.840	372.099	393.813	354.251	2
South Dakota	-	206.629	235.730	221.179	1
Tennessee	358.561	474.985	450.284	427.943	3
Texas	453.651	686.756	951.005	697.137	5
Utah	318.569	311.264	446.237	358.690	2
Vermont	-	207.184	184.175	195.679	0
Virginia	300.791	404.117	512.180	405.696	3
Washington	292.107	302.687	481.923	358.906	2
West Virginia	218.699	212.812	309.808	247.106	1
Wisconsin	303.297	346.124	403.770	351.064	2
Wyoming	-	228.004	286.996	257.500	1

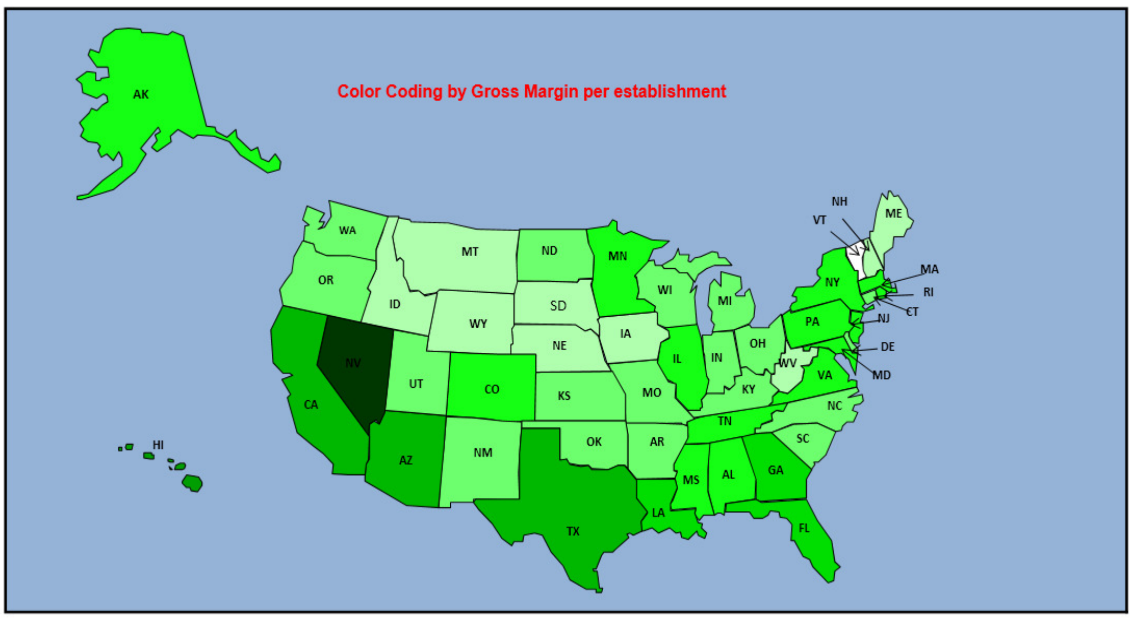

Figure 13: Color Coding by Gross Margin per Establishment

Table 15: Data for Color Coding by Gross Margin per Construction Worker

State	Gross Margin/const. worker (CPI adjusted) Unit: $1000 2007 Value				
	1997	2002	2007	Average	Color Code Value
Alabama	-	50.772	66.526	58.649	3
Alaska	41.280	74.423	108.792	74.831	6
Arizona	44.578	56.068	95.619	65.422	4
Arkansas	49.146	42.902	58.648	50.232	2
California	62.329	61.502	92.426	72.086	5
Colorado	53.486	59.075	67.494	60.019	3
Connecticut	58.385	55.680	99.906	71.324	5
Delaware	32.760	52.547	64.797	50.035	2
District of Columbia	-	80.322	64.970	72.646	5
Florida	62.061	74.164	93.038	76.421	6
Georgia	72.351	64.214	87.807	74.791	6
Hawaii	-	69.886	104.815	87.351	8
Idaho	-	45.052	56.384	50.718	2
Illinois	62.396	63.905	92.378	72.893	5
Indiana	50.764	47.410	60.680	52.951	2
Iowa	41.227	41.128	56.879	46.412	1
Kansas	46.584	43.858	54.545	48.329	2
Kentucky	46.884	49.551	61.405	52.613	2
Louisiana	34.893	37.513	57.533	43.313	1
Maine	38.074	50.706	50.528	46.436	1
Maryland	32.254	54.598	61.711	49.521	2
Massachusetts	77.100	59.376	86.413	74.297	6
Michigan	57.672	57.035	77.020	63.909	4
Minnesota	52.515	60.969	104.324	72.603	5
Mississippi	40.991	46.277	75.456	54.242	2
Missouri	44.529	46.290	56.858	49.226	2
Montana	-	48.547	59.157	53.852	2
Nebraska	44.455	45.514	55.429	48.466	2
Nevada	87.081	60.148	78.984	75.405	6
New Hampshire	52.132	48.587	56.518	52.412	2
New Jersey	65.099	71.292	97.984	78.125	6
New Mexico	34.728	43.776	63.024	47.176	1
New York	-	66.551	93.638	80.094	6
North Carolina	46.714	52.933	68.613	56.087	3
North Dakota	40.116	47.530	43.294	43.647	1
Ohio	54.420	54.481	64.106	57.669	3
Oklahoma	50.091	48.882	55.234	51.402	2
Oregon	54.887	48.071	68.327	57.095	3
Pennsylvania	53.322	58.835	67.102	59.753	3
Rhode Island	-	73.152	126.159	99.655	9

Table 15: Continued

State	Gross Margin/const. worker (CPI adjusted) Unit: $1000 2007 Value				
	1997	2002	2007	Average	Color Code Value
South Carolina	45.994	49.925	62.645	52.855	2
South Dakota	-	41.831	46.933	44.382	1
Tennessee	43.508	54.086	54.489	50.694	2
Texas	48.637	61.452	84.011	64.700	4
Utah	51.780	51.361	67.003	56.715	3
Vermont	-	47.893	42.111	45.002	1
Virginia	42.464	53.873	66.841	54.393	2
Washington	55.170	52.840	74.159	60.723	3
West Virginia	35.323	39.752	50.279	41.785	0
Wisconsin	51.137	53.610	65.439	56.729	3
Wyoming	-	43.656	46.420	45.038	1

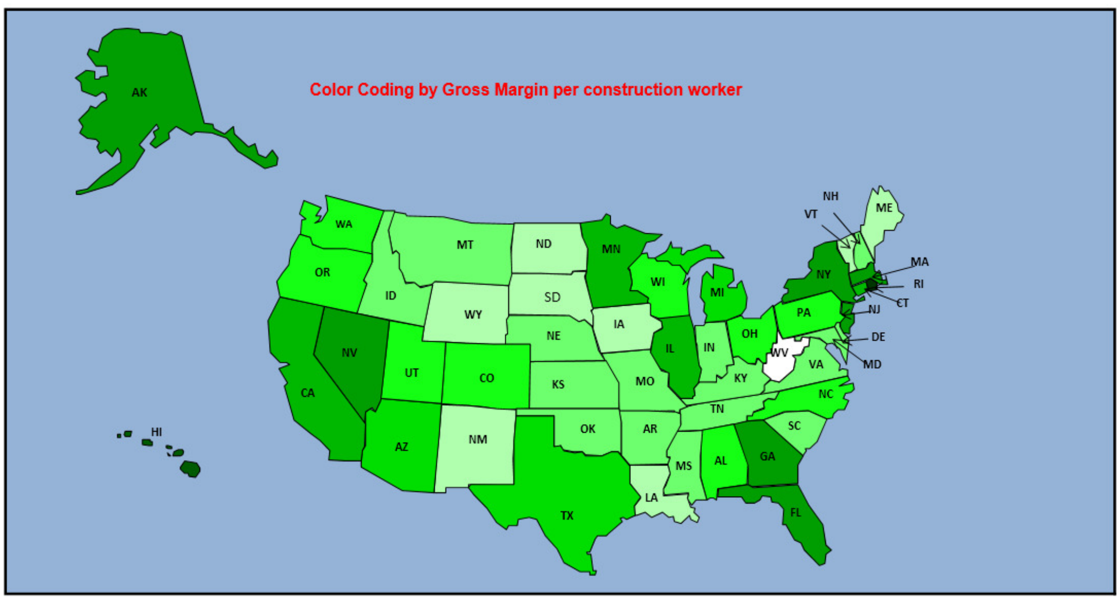

Figure 14: Color Coding by Gross Margin per Construction Worker

Table 16: Data for Color Coding by Labor Productivity

State	Labor Productivity (CPI adjusted) - Unit: $1000 2007 value				
	1997	2002	2007	Average	Color Code Value
Alabama	-	237.99	314.69	276.34	4
Alaska	216.85	317.72	421.46	318.68	5
Arizona	238.82	245.85	342.19	275.62	3
Arkansas	200.11	212.29	274.44	228.95	2
California	279.96	264.87	341.74	295.53	4
Colorado	264.66	289.43	347.17	300.42	4
Connecticut	275.49	287.94	368.12	310.51	5
Delaware	249.75	229.89	290.49	256.71	3
District of Columbia	-	387.29	472.60	429.95	9
Florida	275.99	301.29	363.58	313.62	5
Georgia	314.73	301.51	375.90	330.71	6
Hawaii	-	325.03	405.52	365.27	7
Idaho	-	235.57	261.64	248.60	2
Illinois	279.59	276.41	372.29	309.43	5
Indiana	229.63	242.76	279.16	250.52	3
Iowa	205.83	222.52	281.86	236.74	2
Kansas	231.08	226.88	275.87	244.61	2
Kentucky	204.85	232.12	268.56	235.18	2
Louisiana	167.83	178.08	250.76	198.89	0
Maine	183.29	216.48	236.98	212.25	1
Maryland	166.66	252.59	321.78	247.01	2
Massachusetts	332.05	299.52	403.13	344.90	6
Michigan	272.84	257.32	314.27	281.48	4
Minnesota	247.05	303.94	376.72	309.24	5
Mississippi	200.37	219.70	277.09	232.39	2
Missouri	237.40	259.31	295.17	263.96	3
Montana	-	225.57	265.88	245.73	2
Nebraska	209.62	222.63	260.02	230.76	2
Nevada	257.79	254.15	311.90	274.61	3
New Hampshire	246.28	247.18	277.23	256.90	3
New Jersey	299.42	287.15	364.40	316.99	5
New Mexico	246.51	202.39	250.02	232.97	2
New York	-	277.16	368.65	322.90	5
North Carolina	224.07	238.10	324.20	262.12	3
North Dakota	178.86	204.72	236.11	206.57	1
Ohio	253.55	244.82	294.00	264.12	3
Oklahoma	214.15	232.04	269.08	238.42	2
Oregon	270.11	241.86	310.91	274.29	3
Pennsylvania	245.90	260.21	310.95	272.35	3
Rhode Island	-	256.28	398.15	327.22	5
South Carolina	207.24	207.04	294.97	236.42	2

Table 16: Continued

State	Labor Productivity (CPI adjusted) - Unit: $1000 2007 value				
	1997	2002	2007	Average	Color Code Value
South Dakota	-	214.07	245.27	229.67	2
Tennessee	234.25	243.21	308.27	261.91	3
Texas	233.18	256.68	344.14	278.00	4
Utah	242.54	241.74	294.19	259.49	3
Vermont	-	218.08	250.38	234.23	2
Virginia	212.82	247.41	299.72	253.32	3
Washington	263.21	255.28	324.43	280.98	4
West Virginia	259.05	172.55	201.02	210.87	1
Wisconsin	241.85	253.43	310.97	268.75	3
Wyoming	-	180.79	241.93	211.36	1

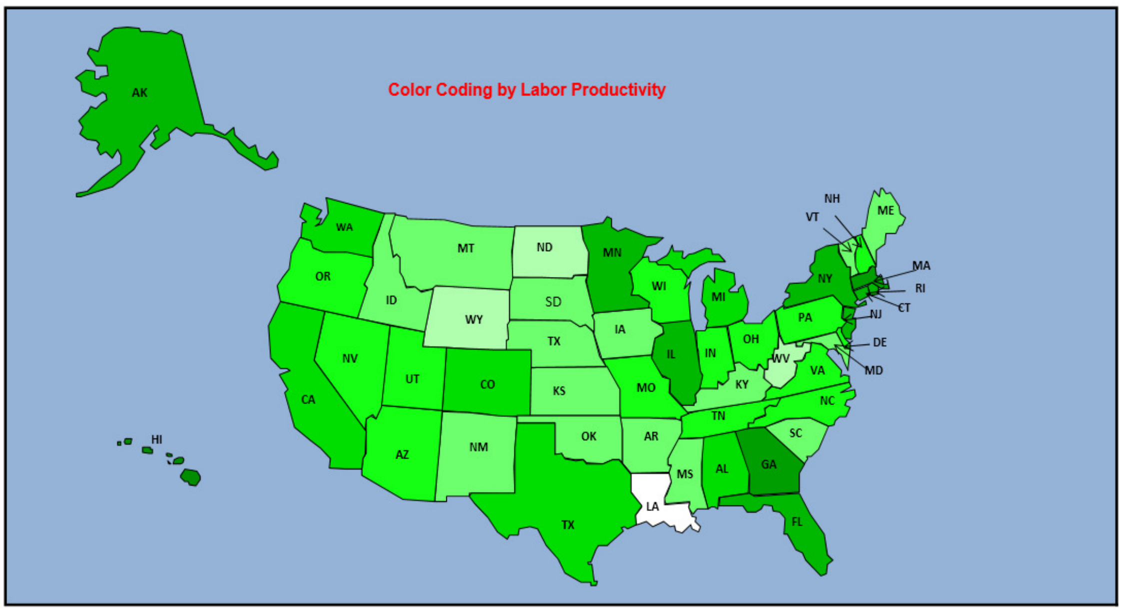

Figure 15: Color Coding by Labor Productivity

6. CONCLUSIONS

6.1 Summary of Findings

The following conclusions can be drawn from the results of this research:

1. Gross Margin of a construction firm showed dependence on the following independent variables:
   - I. Labor Productivity
   - II. Percent of construction work sub-contracted out
   - III. Percent use of rental equipment
   - IV. Percent of cost of materials, components and supplies
2. Labor productivity showed a strong positive relationship on gross margin for all the states.
3. Some of the important states where gross margin showed dependence on "Percent of construction work sub-contracted" along with "Labor Productivity" include Alabama, Kansas, Louisiana, Mississippi, Montana, Nebraska, North Carolina, North Dakota, South Carolina and South Dakota. Percent of construction work sub-contracted out had a negative effect on gross margin. This means that profitability of the construction firm decreases if it subcontracts out the work. Therefore, construction firms which act as prime contractors having limited or no sub-contractors have a higher profitability.
4. Some of the important states where Gross Margin showed dependence on "Percent use of rental equipment" along with "Labor Productivity" include California, Connecticut, Illinois, Massachusetts, Michigan, Nevada, New Jersey,

New York, Pennsylvania, Wisconsin and Washington. Percent use of rental equipment showed to have a positive effect on gross margin. This indicates that it is more profitable for construction firms to use rental equipment.

5. Some of the important states where Gross Margin showed dependence on "Percent of construction work sub-contracted" and "Percent of cost of materials, components and supplies" along with "Labor Productivity" include Florida, District of Columbia, Georgia, Maryland, Texas, Tennessee and Virginia. For this model as well, percent of work sub-contracted out negatively affected gross margin and so did percent cost of materials, components and supplies.
6. The independent variables "Construction worker wages per construction worker" and "Percent of Labor Cost" did not have any significant effect on gross margin in any of the states.
7. Gross margin of states can be expressed as different functions of their labor productivities depending on their values of gross margins and labor productivities over the years. States with low/average/high values of Gross Margins and Labor Productivities followed different predictive equations.
8. District of Columbia, Hawaii, Massachusetts, Georgia, Rhode Island, New York, Alaska, New Jersey, Florida, Connecticut, Illinois and Connecticut recorded exceptionally high average values of labor productivity over 15 years of census data while Louisiana, North Dakota, West Virginia, Wyoming and Maine had an exceptionally low labor productivity.

9. States having exceptionally high gross margin per construction worker from 1993-2007 included Rhode Island, Hawaii, New York, New Jersey, Florida, Nevada, Alaska, Georgia, Massachusetts, Illinois, District of Columbia, Minnesota, California and Connecticut. On the other hand, West Virginia, Louisiana, North Dakota, South Dakota, Vermont, Wyoming, Iowa and Maine had an exceptionally low gross margin per construction worker.
10. Nevada, District of Columbia, Hawaii, Texas, Arizona and California were among the states with exceptionally high gross margin per establishment whereas Vermont, South Dakota, Montana, Maine, Idaho, West Virginia and Wyoming had an exceptionally low gross margin per establishment.

6.2 Scope for Future Research

The research serves as a pilot study and can be developed further in the following areas:

1. Research provides a template which can be expanded when 2012 U.S Census data is made available. This would provide more data points and would lead to a more reliable model. Moreover, the maps can be easily updated to incorporate 2012 data.
2. Labor productivity and gross margin trends can be studied over years. States can be grouped on the basis of increasing/decreasing trends and studied together.

3. Reasons for high/low labor productivity/gross margin can be studied at state level. Also, reasons for gross margin dependence on other factors studied in Model 1 can be studied in depth.
4. Data within a state can be broken down at a construction sub- sector level which would better aid the understanding of the trends at a sub-sector level.
5. Model can be adopted to study counties within big states if their data is made available.

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APPENDIX 1

A. Raw data from 1997 U.S Census Report

State	Average number of construction workers	Number of establishments	Value of construction work ($1,000)	Value added ($1,000)	Cost of materials, components, and supplies ($1,000)	Cost of construction work subcontracted out to others ($1,000)	Total rental costs ($1,000)	Capital expenditures, except land ($1,000)	Total annual payroll ($1,000)	Total payroll, construction workers wages ($1,000)
Alaska	74,875	9,587	12,568,709	5,284,047	4,311,634	3,568,748	173,111	242,614	2,475,750	1,713,247
Arizona	102,055	11,058	18,866,480	7,721,319	5,289,413	6,104,515	269,214	309,293	3,621,170	2,435,273
Arkansas	33,202	5,457	5,143,081	2,426,438	2,096,602	1,322,184	74,917	105,609	982,804	692,563
California	429,811	60,162	93,145,280	42,654,682	23,793,285	27,905,761	1,477,327	1,292,229	19,147,665	13,156,577
Colorado	94,903	14,681	19,442,382	8,370,713	5,339,393	6,026,814	304,571	328,958	3,807,922	2,562,030
Connecticut	45,624	9,058	9,729,275	4,600,200	2,584,039	2,646,984	125,609	165,870	2,246,746	1,402,552
Delaware	15,789	2,294	3,052,420	1,302,070	1,273,709	913,493	128,004	140,711	632,961	439,470
Florida	234,855	36,608	50,173,813	21,555,109	14,149,903	15,224,001	671,001	799,090	8,802,535	5,471,620
Georgia	115,633	17,896	28,171,343	11,572,987	8,271,515	8,742,763	342,507	476,522	4,277,873	2,746,195
Hawaii	16,868	2,335	3,837,876	2,846,704	3,246,743	1,604,956	138,349	107,666	778,800	486,176
Indiana	108,175	15,999	19,228,174	9,241,725	5,928,899	4,408,419	250,029	396,166	4,344,728	3,117,684
Iowa	49,842	7,942	7,941,416	3,651,784	2,900,724	1,653,823	105,152	221,895	1,734,111	1,293,481
Kansas	48,985	7,115	8,762,161	3,856,131	2,924,885	2,300,451	115,515	218,635	1,755,601	1,257,190
Kentucky	61,514	8,878	9,754,414	4,523,159	3,055,089	2,328,648	141,829	190,174	1,958,703	1,421,573
Louisiana	87,215	7,813	11,330,553	5,845,182	3,601,598	2,158,644	232,435	223,896	3,033,161	2,276,753
Maryland	161,859	14,526	20,880,710	8,990,382	5,969,733	6,012,296	271,157	310,502	4,367,540	2,887,288
Massachusetts	79,419	14,959	20,413,384	9,251,351	5,210,904	6,169,002	323,221	319,493	3,868,759	2,585,885
Michigan	143,937	25,400	30,400,068	13,736,838	7,968,224	8,640,740	434,889	595,614	6,280,541	4,041,691
Minnesota	94,779	12,993	18,125,070	8,095,350	5,069,225	5,367,540	259,196	379,450	3,603,848	2,573,960
Mississippi	38,544	4,823	5,978,216	2,663,025	2,747,867	1,584,492	98,605	185,900	1,155,493	829,263
Missouri	102,153	15,019	18,772,419	8,067,302	5,318,279	5,450,555	224,249	343,907	3,978,052	2,790,580
Nebraska	32,751	5,199	5,314,402	2,597,091	2,359,048	1,326,799	127,522	184,145	1,158,390	823,762
Nevada	55,428	4,435	11,060,772	6,434,614	3,305,872	3,346,530	205,541	239,403	2,253,374	1,586,736

New Jersey	105,761	22,103	24,512,851	11,222,001	6,759,933	6,015,925	351,518	351,254	5,189,673	3,469,348
New Mexico	31,811	4,673	6,070,071	2,144,162	2,216,341	3,669,780	81,470	132,178	1,075,352	747,510
North Carolina	152,817	23,991	26,505,734	11,580,846	8,149,608	7,162,640	351,434	525,795	5,177,635	3,473,737
Ohio	169,029	26,047	33,174,507	15,245,534	8,622,848	8,626,583	492,239	565,179	7,067,686	4,917,971
Oklahoma	39,224	6,751	6,502,287	3,026,992	2,388,112	1,519,117	116,939	132,704	1,256,439	864,432
Oregon	61,927	11,740	12,948,074	5,736,105	3,673,207	3,727,016	221,598	234,444	2,648,953	1,915,581
Pennsylvania	175,589	27,563	33,422,996	15,966,474	9,058,253	8,348,380	487,655	955,464	7,275,816	5,101,266
South Carolina	67,320	10,431	10,799,759	4,841,699	3,573,724	2,687,026	148,115	184,067	2,112,692	1,459,202
Tennessee	94,107	11,419	17,064,150	7,133,538	5,171,461	4,895,109	244,424	359,458	3,360,243	2,260,724
Texas	329,395	35,315	59,456,723	26,666,766	14,444,035	16,343,518	912,846	954,289	12,398,272	8,243,049
Utah	44,838	7,288	8,418,199	3,637,594	2,655,615	2,525,963	109,506	152,539	1,578,334	1,159,115
Virginia	138,382	19,536	22,796,777	10,131,890	6,491,645	6,141,353	297,620	448,112	4,837,441	3,207,757
Washington	105,195	19,868	21,433,497	9,818,055	5,692,391	6,072,637	352,437	444,659	4,528,501	3,162,744
West Virginia	27,892	4,505	5,593,087	1,706,203	1,448,797	3,675,720	77,695	108,514	757,335	569,222
Wisconsin	88,818	14,975	16,627,572	8,009,497	4,928,061	4,133,624	239,830	390,032	3,863,850	2,799,438

B. Raw data from 2002 U.S Census Report

State	Average number of construction workers	Number of establishments	Value of construction work ($1,000)	Value added ($1,000)	Cost of materials, components, and supplies ($1,000)	Cost of construction work subcontracted out to others ($1,000)	Total rental costs ($1,000)	Capital expenditures, except land ($1,000)	Total annual payroll ($1,000)	Total payroll, construction workers wages ($1,000)
Alabama	74,668	9,345	15,418,544	6,767,692	4,134,197	4,464,744	226,265	259,398	2,992,730	2,079,273
Alaska	15,836	2,359	4,365,499	2,167,997	1,138,341	1,049,402	95,890	111,074	938,457	652,374
Arizona	134,029	12,991	28,589,815	12,949,890	6,982,479	8,663,357	411,701	389,121	5,628,936	3,825,246
Arkansas	35,384	5,637	6,517,510	2,886,973	1,960,268	1,671,670	122,984	148,890	1,297,957	890,071
California	649,877	69,023	149,352,993	72,494,944	35,070,040	41,262,414	2,646,555	2,182,999	32,986,608	22,282,523
Colorado	129,110	17,998	32,422,778	13,913,492	8,776,818	9,593,392	537,893	538,269	6,219,618	4,223,457
Connecticut	54,386	9,187	13,587,064	6,112,091	3,828,087	3,576,972	206,560	225,115	3,052,989	2,017,928
Delaware	19,314	2,407	3,852,446	1,924,347	1,008,115	902,803	61,962	73,976	907,842	649,553
DC	4,082	359	1,371,681	589,372	195,481	579,972	18,174	13,492	273,225	152,491

Florida	301,128	40,830	78,720,223	34,845,983	21,735,416	21,920,368	1,026,601	1,190,032	13,252,374	8,264,682
Georgia	155,902	20,257	40,784,265	16,904,347	11,207,338	12,730,742	551,356	814,715	6,852,101	4,425,335
Hawaii	19,726	2,350	5,562,996	2,527,112	1,289,177	1,753,440	104,863	87,095	1,139,031	770,909
Idaho	26,709	5,745	5,459,096	2,281,771	1,572,341	1,561,662	87,347	113,610	1,036,778	721,430
Illinois	228,707	30,555	54,851,037	27,319,676	13,125,357	14,206,655	854,925	905,499	12,878,044	9,091,016
Indiana	110,124	15,512	23,195,712	10,549,869	6,493,542	6,080,832	346,132	389,665	5,284,119	3,764,394
Iowa	50,687	8,538	9,786,194	4,447,735	2,970,828	2,371,445	162,277	234,323	2,242,375	1,604,194
Kansas	51,880	7,518	10,212,672	4,647,165	2,967,318	2,577,224	164,381	210,739	2,297,820	1,623,918
Kentucky	61,986	8,814	12,483,652	5,760,848	3,491,975	3,207,027	197,731	261,056	2,637,092	1,828,780
Louisiana	98,053	7,986	15,149,836	7,895,625	3,990,950	3,181,167	308,119	387,459	4,008,618	3,022,469
Maine	22,332	4,797	4,194,524	2,119,005	1,131,610	933,828	61,811	129,800	944,905	657,708
Maryland	134,161	15,433	29,402,444	13,934,047	7,224,355	8,225,573	541,870	447,436	6,589,271	4,327,165
Massachusetts	120,538	17,107	31,325,634	13,973,097	7,329,736	9,884,210	546,993	443,866	6,772,400	4,590,378
Michigan	161,667	26,014	36,094,747	17,388,942	9,332,305	9,293,972	585,816	694,276	8,108,488	5,677,748
Minnesota	109,689	16,952	28,926,697	12,608,748	7,651,650	8,643,080	411,792	554,078	5,840,385	4,028,313
Mississippi	37,328	4,588	7,115,706	3,259,964	2,096,832	1,723,967	144,888	181,710	1,434,567	1,020,149
Missouri	115,050	15,448	25,885,182	11,051,106	6,459,085	8,301,535	328,991	430,558	5,670,754	3,963,880
Montana	16,831	4,025	3,294,142	1,552,865	955,735	796,104	64,724	120,729	658,456	470,451
Nebraska	34,228	5,579	6,611,631	2,998,641	1,854,180	1,754,631	105,056	134,010	1,407,899	981,420
Nevada	72,088	4,962	15,896,085	7,756,927	3,984,500	4,169,833	279,804	224,198	3,490,815	2,490,950
New Hampshire	24,165	4,394	5,182,476	2,465,789	1,293,828	1,380,569	82,712	116,928	1,247,448	807,893
New Jersey	150,444	23,612	37,482,438	18,797,199	9,032,153	9,570,595	594,079	634,184	8,262,952	5,589,286
New Mexico	33,969	4,768	5,965,217	2,840,342	1,626,866	1,461,792	102,410	118,537	1,329,192	911,252
New York	270,208	41,962	64,979,357	32,304,936	15,553,010	16,704,391	947,036	880,311	14,874,984	10,122,014
North Carolina	164,379	25,275	33,958,390	15,503,497	9,421,416	8,921,073	514,182	724,360	6,715,454	4,442,518
North Dakota	13,022	2,021	2,313,075	1,150,677	702,951	441,995	41,323	55,536	516,797	373,748
Ohio	187,434	26,855	39,814,955	19,418,874	10,559,723	9,780,490	711,708	676,017	9,171,095	6,244,626
Oklahoma	47,089	7,797	9,480,368	4,207,377	2,851,350	2,385,732	164,697	209,229	1,836,310	1,302,214
Oregon	65,006	11,854	13,641,611	6,247,422	3,606,887	3,739,842	232,805	200,024	3,103,299	2,188,654
Pennsylvania	204,329	27,589	46,132,217	22,217,427	11,862,268	11,910,739	773,830	869,943	10,143,071	6,976,591
Rhode Island	19,401	3,192	4,314,062	2,255,726	948,181	1,100,048	73,836	64,968	885,539	601,332
South Carolina	84,526	11,341	15,184,159	7,492,668	3,992,354	3,602,282	186,349	247,105	3,397,754	2,434,942
South Dakota	14,058	2,846	2,611,128	1,161,106	830,753	605,001	36,104	80,722	534,046	375,552

Tennessee	92,826	10,570	19,588,060	9,197,180	5,078,722	5,216,267	271,542	376,585	4,192,945	2,873,378
Texas	418,458	37,444	93,193,595	44,004,429	25,556,219	23,328,707	1,508,316	1,461,188	18,723,430	12,552,543
Utah	50,828	8,387	10,660,972	4,680,215	2,992,279	2,980,999	168,303	187,151	2,059,700	1,436,388
Vermont	11,745	2,715	2,222,352	1,074,243	552,325	592,320	35,012	55,923	495,252	331,914
Virginia	155,344	20,709	33,347,592	15,270,789	8,929,295	9,015,257	507,052	565,053	6,937,460	4,500,989
Washington	124,311	21,701	27,533,813	12,954,634	7,305,314	7,304,737	472,310	452,348	6,330,733	4,340,243
West Virginia	22,324	4,170	3,342,166	1,847,723	889,180	597,275	66,878	96,283	914,587	677,017
Wisconsin	104,637	16,207	23,008,114	11,003,705	6,563,237	5,540,398	346,883	535,151	5,254,483	3,691,203
Wyoming	13,412	2,568	2,103,801	1,119,798	554,024	431,524	39,740	72,268	499,770	365,504

C. Raw data from 2007 U.S Census Report

State	Average number of constructi on workers	Number of establishments	Value of construction work ($1,000)	Value added ($1,000)	Cost of materials, components, and supplies ($1,000)	Cost of construction work subcontracted out to others ($1,000)	Total rental costs ($1,000)	Capital expenditure s, except land ($1,000)	Total annual payroll ($1,000)	Total payroll, construction workers wages ($1,000)
Alabama	77,484	9,222	24,383,488	10,037,530	8,648,635	5,425,045	325,019	384,773	4,173,053	2,711,165
Alaska	14,384	2,382	6,062,233	3,142,624	1,708,512	1,213,850	121,406	118,624	1,337,737	871,538
Arizona	161,069	15,463	55,116,528	25,936,601	16,146,324	12,604,248	808,546	655,707	9,071,092	5,744,042
Arkansas	37,382	5,762	10,259,048	4,335,281	3,231,828	2,553,543	150,827	185,608	1,806,453	1,228,260
California	628,249	72,047	214,699,210	106,645,829	62,731,336	43,663,343	3,470,125	2,197,707	42,911,461	27,788,717
Colorado	122,298	17,745	42,457,870	17,210,015	13,917,440	10,908,997	717,346	568,592	7,669,635	4,838,935
Connecticut	48,354	8,962	17,799,871	9,011,928	5,007,565	3,562,512	203,668	184,181	3,793,226	2,404,705
Delaware	18,626	2,702	5,410,748	2,480,567	1,762,776	1,106,018	80,285	63,358	1,130,012	756,566
DC	5,094	367	2,407,439	779,687	1,063,377	552,064	24,560	15,650	408,519	221,007
Florida	319,761	51,089	116,259,685	51,945,109	37,492,302	25,814,837	1,449,009	1,296,734	19,449,378	11,415,521
Georgia	154,596	20,549	58,113,222	24,806,907	19,754,444	12,482,251	681,724	989,109	9,561,411	5,993,067
Hawaii	25,124	2,756	10,188,239	4,793,720	3,096,039	2,222,953	131,892	129,836	1,898,628	1,239,430
Idaho	37,699	7,884	9,863,541	4,180,415	3,289,505	2,290,737	131,873	206,010	1,716,921	1,193,976

Illinois	192,144	30,204	71,532,838	34,184,177	20,962,124	15,877,725	969,346	937,154	14,527,812	9,966,841
Indiana	107,165	15,623	29,916,660	13,840,216	9,192,851	6,639,506	455,093	420,927	6,461,377	4,438,512
Iowa	52,332	8,006	14,750,153	6,364,980	5,087,570	3,144,388	211,876	281,241	2,895,273	2,014,840
Kansas	49,625	7,155	13,690,021	5,936,499	4,389,364	3,167,865	189,638	247,513	2,792,557	1,903,869
Kentucky	60,359	8,592	16,210,034	7,378,284	5,132,912	3,513,521	232,526	316,888	3,122,499	2,091,008
Louisiana	99,845	8,551	25,036,703	12,561,288	8,009,381	3,910,354	519,796	514,150	5,782,958	3,854,774
Maine	22,562	4,938	5,346,639	2,444,855	1,681,511	1,129,324	80,709	98,943	1,125,200	785,273
Maryland	136,307	15,581	43,860,753	18,550,000	12,959,167	12,003,131	603,144	621,473	8,913,713	5,547,466
Massachusetts	90,581	17,169	36,516,145	16,049,315	10,168,704	9,868,884	474,573	315,275	7,432,056	4,629,585
Michigan	111,186	21,781	34,942,476	16,841,871	10,444,717	7,267,225	550,423	499,513	7,228,367	4,790,954
Minnesota	97,327	15,843	36,664,660	17,984,697	10,033,862	8,275,093	515,912	503,509	6,811,722	4,650,999
Mississippi	41,707	4,741	11,556,615	5,644,213	3,746,393	1,975,631	155,995	254,529	2,086,629	1,425,378
Missouri	119,098	15,213	35,153,671	14,748,999	10,203,488	9,981,480	414,379	432,828	7,130,066	4,880,969
Montana	22,653	5,299	6,023,063	2,728,625	1,929,128	1,259,059	128,862	159,587	1,100,089	789,437
Nebraska	32,196	5,440	8,371,554	3,722,537	2,927,162	1,630,182	120,783	153,340	1,663,806	1,122,258
Nevada	92,796	5,238	28,943,523	13,863,452	9,327,413	5,590,917	553,889	261,924	5,718,224	3,876,727
New Hampshire	21,045	4,329	5,834,306	2,745,455	1,829,281	1,163,087	95,735	100,786	1,359,517	867,250
New Jersey	124,336	23,083	45,307,794	22,879,952	13,974,093	8,140,353	591,259	538,641	9,567,063	6,169,131
New Mexico	40,827	5,288	10,207,379	4,943,162	3,194,527	1,889,223	217,961	159,290	1,992,838	1,338,489
New York	242,354	43,377	89,342,984	42,839,861	27,154,672	18,399,075	999,383	870,769	18,276,272	11,932,423
North Carolina	168,806	25,417	54,726,930	22,653,095	18,756,660	12,645,681	713,288	1,061,787	9,295,654	5,614,830
North Dakota	15,346	2,079	3,623,420	1,560,197	1,307,429	698,572	50,526	78,719	766,563	566,845
Ohio	160,086	22,898	47,065,896	21,681,704	14,494,925	10,675,958	770,184	743,406	9,905,604	6,638,157
Oklahoma	51,845	7,600	13,950,476	5,983,833	4,560,422	3,221,771	228,411	289,714	2,602,079	1,778,151
Oregon	73,597	13,391	22,882,376	10,141,166	6,693,376	5,873,514	374,112	321,082	4,417,274	3,004,838
Pennsylvania	187,263	28,441	58,229,329	26,807,469	18,445,518	12,530,879	831,624	995,502	12,414,625	8,262,948
Rhode Island	14,296	3,574	5,692,023	2,995,081	1,416,835	1,244,788	65,648	51,070	1,074,799	683,980
South Carolina	76,060	12,099	22,435,508	9,222,504	7,842,768	5,094,605	268,782	334,433	3,854,544	2,378,828
South Dakota	15,696	3,125	3,849,777	1,597,157	1,350,322	862,957	40,239	102,833	717,430	514,890
Tennessee	89,967	10,887	27,734,088	10,946,992	8,966,143	7,588,523	351,708	491,864	5,201,182	3,263,205
Texas	420,427	37,140	144,686,281	66,043,999	46,924,335	30,257,419	2,157,113	2,162,770	26,403,791	16,833,105
Utah	66,793	10,029	19,650,055	8,526,621	6,613,957	4,420,145	271,863	392,490	3,386,955	2,306,084
Vermont	12,329	2,819	3,086,978	1,285,586	932,829	822,635	41,313	56,968	668,117	434,472

Virginia	171,567	22,390	51,422,085	22,746,545	15,918,772	12,015,774	632,470	667,504	9,978,860	6,344,721
Washington	145,047	22,320	47,058,165	21,741,396	13,801,821	11,258,587	807,214	665,867	9,511,790	6,467,907
West Virginia	24,524	3,980	4,929,698	2,651,353	1,597,801	602,646	100,516	124,265	1,193,537	892,598
Wisconsin	90,504	14,668	28,144,156	12,702,484	8,590,962	6,765,669	378,124	467,403	5,934,457	4,036,741
Wyoming	17,200	2,782	4,161,168	2,013,019	1,347,846	742,691	118,946	146,421	949,229	686,362

APPENDIX 2

A. Data for Labor Productivity

State	Labor Productivity (CPI adjusted) - Unit: $1000 2007 value			
	1997	2002	2007	Average
Alabama	-	237.99	314.69	276.34
Alaska	216.85	317.72	421.46	318.68
Arizona	238.82	245.85	342.19	275.62
Arkansas	200.11	212.29	274.44	228.95
California	279.96	264.87	341.74	295.53
Colorado	264.66	289.43	347.17	300.42
Connecticut	275.49	287.94	368.12	310.51
Delaware	249.75	229.89	290.49	256.71
District of Columbia	-	387.29	472.60	429.95
Florida	275.99	301.29	363.58	313.62
Georgia	314.73	301.51	375.90	330.71
Hawaii	-	325.03	405.52	365.27
Idaho	-	235.57	261.64	248.60
Illinois	279.59	276.41	372.29	309.43
Indiana	229.63	242.76	279.16	250.52
Iowa	205.83	222.52	281.86	236.74
Kansas	231.08	226.88	275.87	244.61
Kentucky	204.85	232.12	268.56	235.18
Louisiana	167.83	178.08	250.76	198.89
Maine	-	216.48	236.98	226.73
Maryland	166.66	252.59	321.78	247.01
Massachusetts	332.05	299.52	403.13	344.90
Michigan	272.84	257.32	314.27	281.48
Minnesota	247.05	303.94	376.72	309.24
Mississippi	200.37	219.70	277.09	232.39
Missouri	237.40	259.31	295.17	263.96
Montana	-	225.57	265.88	245.73
Nebraska	209.62	222.63	260.02	230.76
Nevada	257.79	254.15	311.90	274.61
New Hampshire	-	247.18	277.23	262.20
New Jersey	299.42	287.15	364.40	316.99
New Mexico	246.51	202.39	250.02	232.97
New York	-	277.16	368.65	322.90
North Carolina	224.07	238.10	324.20	262.12
North Dakota	-	204.72	236.11	220.42
Ohio	253.55	244.82	294.00	264.12
Oklahoma	214.15	232.04	269.08	238.42
Oregon	270.11	241.86	310.91	274.29

Pennsylvania	245.90	260.21	310.95	272.35
Rhode Island	-	256.28	398.15	327.22
South Carolina	207.24	207.04	294.97	236.42
South Dakota	-	214.07	245.27	229.67
Tennessee	234.25	243.21	308.27	261.91
Texas	233.18	256.68	344.14	278.00
Utah	242.54	241.74	294.19	259.49
Vermont	-	218.08	250.38	234.23
Virginia	212.82	247.41	299.72	253.32
Washington	263.21	255.28	324.43	280.98
West Virginia	259.05	172.55	201.02	210.87
Wisconsin	241.85	253.43	310.97	268.75
Wyoming	-	180.79	241.93	211.36

B. Data for construction worker wages/construction worker

State	Construction worker wages/worker (CPI adjusted) Unit: $1000 2007 value			
	1997	2002	2007	Average
Alabama	-	32.0947	34.9900	33.5423
Alaska	29.559	47.4796	60.5908	45.8766
Arizona	30.827	32.8940	35.6620	33.1275
Arkansas	26.947	28.9917	32.8570	29.5985
California	39.544	39.5175	44.2320	41.0977
Colorado	34.875	37.7020	39.5668	37.3813
Connecticut	39.713	42.7636	49.7313	44.0694
Delaware	35.957	38.7613	40.6188	38.4458
District of Columbia	-	43.0554	43.3857	43.2206
Florida	30.097	31.6323	35.7002	32.4766
Georgia	30.680	32.7153	38.7660	34.0539
Hawaii	-	45.0423	49.3325	47.1874
Idaho	-	31.1310	31.6713	31.4011
Illinois	44.886	45.8130	51.8717	47.5234
Indiana	37.232	39.3975	41.4176	39.3491
Iowa	33.526	36.4768	38.5011	36.1678
Kansas	33.155	36.0761	38.3651	35.8654
Kentucky	29.854	34.0035	34.6429	32.8336
Louisiana	33.724	35.5269	38.6076	35.9528
Maine	-	33.9439	34.8051	34.3745
Maryland	23.044	37.1735	40.6983	33.6387
Massachusetts	42.063	43.8915	51.1099	45.6880
Michigan	36.275	40.4772	43.0895	39.9471

Minnesota	35.083	42.3269	47.7873	41.7325
Mississippi	27.794	31.4981	34.1760	31.1560
Missouri	-	39.7091	40.9828	40.3459
Montana	35.542	32.2152	34.8491	34.2022
Nebraska	32.493	33.0468	34.8571	33.4656
Nevada	36.982	39.8252	41.7769	39.5279
New Hampshire	-	38.5321	41.2093	39.8707
New Jersey	42.377	42.8191	49.6166	44.9377
New Mexico	30.357	30.9180	32.7844	31.3530
New York	-	43.1742	49.2355	46.2049
North Carolina	29.365	31.1486	33.2620	31.2587
North Dakota	-	33.0794	36.9376	35.0085
Ohio	37.587	38.3985	41.4662	39.1505
Oklahoma	28.470	31.8727	34.2974	31.5468
Oregon	39.961	38.8043	40.8283	39.8644
Pennsylvania	37.531	39.3522	44.1248	40.3361
Rhode Island	-	35.7229	47.8442	41.7835
South Carolina	28.002	33.2012	31.2757	30.8262
South Dakota	21.813	30.7895	32.8039	28.4687
Tennessee	-	35.6762	36.2711	35.9737
Texas	32.328	34.5729	40.0381	35.6464
Utah	33.396	32.5705	34.5258	33.4974
Vermont	-	32.5708	35.2398	33.9053
Virginia	29.946	33.3941	36.9810	33.4403
Washington	38.840	40.2402	44.5918	41.2241
West Virginia	26.364	34.9529	36.3969	32.5713
Wisconsin	40.718	40.6573	44.6029	41.9926
Wyoming	-	31.4090	39.9048	35.6569

C. Data for Percent of construction work sub-contracted out.

State	% construction work sub-contracted out			
	1997	2002	2007	Average
Alabama	-	28.96%	22.25%	25.60%
Alaska	28.39%	24.04%	20.02%	24.15%
Arizona	32.36%	30.30%	22.87%	28.51%
Arkansas	25.71%	25.65%	24.89%	25.42%
California	29.96%	27.63%	20.34%	25.97%
Colorado	31.00%	29.59%	25.69%	28.76%
Connecticut	27.21%	26.33%	20.01%	24.52%
Delaware	29.93%	23.43%	20.44%	24.60%

District of Columbia	-	42.28%	22.93%	32.61%
Florida	30.34%	27.85%	22.20%	26.80%
Georgia	31.03%	31.21%	21.48%	27.91%
Hawaii	-	31.52%	21.82%	26.67%
Idaho	-	28.61%	23.22%	25.92%
Illinois	27.22%	25.90%	22.20%	25.11%
Indiana	22.93%	26.22%	22.19%	23.78%
Iowa	20.83%	24.23%	21.32%	22.13%
Kansas	26.25%	25.24%	23.14%	24.88%
Kentucky	23.87%	25.69%	21.67%	23.75%
Louisiana	19.05%	21.00%	15.62%	18.56%
Maine	-	22.26%	21.12%	21.69%
Maryland	28.79%	27.98%	27.37%	28.05%
Massachusetts	30.22%	31.55%	27.03%	29.60%
Michigan	28.42%	25.75%	20.80%	24.99%
Minnesota	29.61%	29.88%	22.57%	27.35%
Mississippi	26.50%	24.23%	17.10%	22.61%
Missouri	29.03%	32.07%	28.39%	29.83%
Montana	-	24.17%	20.90%	22.54%
Nebraska	24.97%	26.54%	19.47%	23.66%
Nevada	30.26%	26.23%	19.32%	25.27%
New Hampshire	-	26.64%	19.94%	23.29%
New Jersey	24.54%	25.53%	17.97%	22.68%
New Mexico	60.46%	24.51%	18.51%	34.49%
New York	-	25.71%	20.59%	23.15%
North Carolina	27.02%	26.27%	23.11%	25.47%
North Dakota	-	19.11%	19.28%	19.19%
Ohio	26.00%	24.56%	22.68%	24.42%
Oklahoma	23.36%	25.16%	23.09%	23.87%
Oregon	28.78%	27.41%	25.67%	27.29%
Pennsylvania	24.98%	25.82%	21.52%	24.11%
Rhode Island	-	25.50%	21.87%	23.68%
South Carolina	24.88%	23.72%	22.71%	23.77%
South Dakota	-	23.17%	22.42%	22.79%
Tennessee	28.69%	26.63%	27.36%	27.56%
Texas	27.49%	25.03%	20.91%	24.48%
Utah	30.01%	27.96%	22.49%	26.82%
Vermont	-	26.65%	26.65%	26.65%
Virginia	26.94%	27.03%	23.37%	25.78%
Washington	28.33%	26.53%	23.92%	26.26%
West Virginia	65.72%	17.87%	12.22%	31.94%
Wisconsin	24.86%	24.08%	24.04%	24.33%
Wyoming	-	20.51%	17.85%	19.18%

D. Data for Percent use of rental equipment.

State	Use of rental equipment %			
	1997	2002	2007	Average
Alabama	-	1.47%	1.33%	1.40%
Alaska	1.38%	2.20%	2.00%	1.86%
Arizona	1.43%	1.44%	1.47%	1.44%
Arkansas	1.46%	1.89%	1.47%	1.60%
California	1.59%	1.77%	1.62%	1.66%
Colorado	1.57%	1.66%	1.69%	1.64%
Connecticut	1.29%	1.52%	1.14%	1.32%
Delaware	4.19%	1.61%	1.48%	2.43%
District of Columbia	-	1.32%	1.02%	1.17%
Florida	1.34%	1.30%	1.25%	1.30%
Georgia	1.22%	1.35%	1.17%	1.25%
Hawaii	-	1.89%	1.29%	1.59%
Idaho	-	1.60%	1.34%	1.47%
Illinois	1.48%	1.56%	1.36%	1.47%
Indiana	1.30%	1.49%	1.52%	1.44%
Iowa	1.32%	1.66%	1.44%	1.47%
Kansas	1.32%	1.61%	1.39%	1.44%
Kentucky	1.45%	1.58%	1.43%	1.49%
Louisiana	2.05%	2.03%	2.08%	2.05%
Maine	-	1.47%	1.51%	1.49%
Maryland	1.30%	1.84%	1.38%	1.51%
Massachusetts	1.58%	1.75%	1.30%	1.54%
Michigan	1.43%	1.62%	1.58%	1.54%
Minnesota	1.43%	1.42%	1.41%	1.42%
Mississippi	1.65%	2.04%	1.35%	1.68%
Missouri	1.19%	1.27%	1.18%	1.21%
Montana	-	1.96%	2.14%	2.05%
Nebraska	2.40%	1.59%	1.44%	1.81%
Nevada	1.86%	1.76%	1.91%	1.84%
New Hampshire	-	1.60%	1.64%	1.62%
New Jersey	1.43%	1.58%	1.30%	1.44%
New Mexico	1.34%	1.72%	2.14%	1.73%
New York	-	1.46%	1.12%	1.29%
North Carolina	1.33%	1.51%	1.30%	1.38%
North Dakota	-	1.79%	1.39%	1.59%
Ohio	1.48%	1.79%	1.64%	1.64%
Oklahoma	1.80%	1.74%	1.64%	1.72%
Oregon	1.71%	1.71%	1.63%	1.68%
Pennsylvania	1.46%	1.68%	1.43%	1.52%
Rhode Island	-	1.71%	1.15%	1.43%

South Carolina	1.37%	1.23%	1.20%	1.27%
South Dakota	-	1.38%	1.05%	1.21%
Tennessee	1.43%	1.39%	1.27%	1.36%
Texas	1.54%	1.62%	1.49%	1.55%
Utah	1.30%	1.58%	1.38%	1.42%
Vermont	-	1.58%	1.34%	1.46%
Virginia	1.31%	1.52%	1.23%	1.35%
Washington	1.64%	1.72%	1.72%	1.69%
West Virginia	1.39%	2.00%	2.04%	1.81%
Wisconsin	1.44%	1.51%	1.34%	1.43%
Wyoming	-	1.89%	2.86%	2.37%

E. Data for Percent of labor cost.

State	Labor cost %			
	1997	2002	2007	Average
Alabama	-	13.49%	11.12%	12.30%
Alaska	13.63%	14.94%	14.38%	14.32%
Arizona	12.91%	13.38%	10.42%	12.24%
Arkansas	13.47%	13.66%	11.97%	13.03%
California	14.12%	14.92%	12.94%	14.00%
Colorado	13.18%	13.03%	11.40%	12.53%
Connecticut	14.42%	14.85%	13.51%	14.26%
Delaware	14.40%	16.86%	13.98%	15.08%
District of Columbia	-	11.12%	9.18%	10.15%
Florida	10.91%	10.50%	9.82%	10.41%
Georgia	9.75%	10.85%	10.31%	10.30%
Hawaii	-	13.86%	12.17%	13.01%
Idaho	-	13.22%	12.10%	12.66%
Illinois	16.05%	16.57%	13.93%	15.52%
Indiana	16.21%	16.23%	14.84%	15.76%
Iowa	16.29%	16.39%	13.66%	15.45%
Kansas	14.35%	15.90%	13.91%	14.72%
Kentucky	14.57%	14.65%	12.90%	14.04%
Louisiana	20.09%	19.95%	15.40%	18.48%
Maine	-	15.68%	14.69%	15.18%
Maryland	13.83%	14.72%	12.65%	13.73%
Massachusetts	12.67%	14.65%	12.68%	13.33%
Michigan	13.30%	15.73%	13.71%	14.25%
Minnesota	14.20%	13.93%	12.69%	13.60%
Mississippi	13.87%	14.34%	12.33%	13.51%

Missouri	14.87%	15.31%	13.88%	14.69%
Montana	-	14.28%	13.11%	13.69%
Nebraska	15.50%	14.84%	13.41%	14.58%
Nevada	14.35%	15.67%	13.39%	14.47%
New Hampshire	-	15.59%	14.86%	15.23%
New Jersey	14.15%	14.91%	13.62%	14.23%
New Mexico	12.31%	15.28%	13.11%	13.57%
New York	-	15.58%	13.36%	14.47%
North Carolina	13.11%	13.08%	10.26%	12.15%
North Dakota	-	16.16%	15.64%	15.90%
Ohio	14.82%	15.68%	14.10%	14.87%
Oklahoma	13.29%	13.74%	12.75%	13.26%
Oregon	14.79%	16.04%	13.13%	14.66%
Pennsylvania	15.26%	15.12%	14.19%	14.86%
Rhode Island	-	13.94%	12.02%	12.98%
South Carolina	13.51%	16.04%	10.60%	13.38%
South Dakota	-	14.38%	13.37%	13.88%
Tennessee	13.25%	14.67%	11.77%	13.23%
Texas	13.86%	13.47%	11.63%	12.99%
Utah	13.77%	13.47%	11.74%	12.99%
Vermont	-	14.94%	14.07%	14.50%
Virginia	14.07%	13.50%	12.34%	13.30%
Washington	14.76%	15.76%	13.74%	14.75%
West Virginia	10.18%	20.26%	18.11%	16.18%
Wisconsin	16.84%	16.04%	14.34%	15.74%
Wyoming	-	17.37%	16.49%	16.93%

F. Data for Percent of cost of materials, components and supplies.

State	Cost of materials, components and supplies %			
	1997	2002	2007	Average
Alabama	-	26.81%	35.47%	31.14%
Alaska	34.30%	26.08%	28.18%	29.52%
Arizona	28.04%	24.42%	29.29%	27.25%
Arkansas	40.77%	30.08%	31.50%	34.11%
California	25.54%	23.48%	29.22%	26.08%
Colorado	27.46%	27.07%	32.78%	29.10%
Connecticut	26.56%	28.17%	28.13%	27.62%
Delaware	41.73%	26.17%	32.58%	33.49%
District of Columbia	-	14.25%	44.17%	29.21%
Florida	28.20%	27.61%	32.25%	29.35%

Georgia	29.36%	27.48%	33.99%	30.28%
Hawaii	-	23.17%	30.39%	26.78%
Idaho	-	28.80%	33.35%	31.08%
Illinois	26.50%	23.93%	29.30%	26.58%
Indiana	30.83%	27.99%	30.73%	29.85%
Iowa	36.53%	30.36%	34.49%	33.79%
Kansas	33.38%	29.06%	32.06%	31.50%
Kentucky	31.32%	27.97%	31.67%	30.32%
Louisiana	31.79%	26.34%	31.99%	30.04%
Maine	-	26.98%	31.45%	29.21%
Maryland	28.59%	24.57%	29.55%	27.57%
Massachusetts	25.53%	23.40%	27.85%	25.59%
Michigan	26.21%	25.86%	29.89%	27.32%
Minnesota	27.97%	26.45%	27.37%	27.26%
Mississippi	45.96%	29.47%	32.42%	35.95%
Missouri	28.33%	24.95%	29.03%	27.44%
Montana	-	29.01%	32.03%	30.52%
Nebraska	44.39%	28.04%	34.97%	35.80%
Nevada	29.89%	25.07%	32.23%	29.06%
New Hampshire	-	24.97%	31.35%	28.16%
New Jersey	27.58%	24.10%	30.84%	27.51%
New Mexico	36.51%	27.27%	31.30%	31.69%
New York	-	23.94%	30.39%	27.16%
North Carolina	30.75%	27.74%	34.27%	30.92%
North Dakota	-	30.39%	36.08%	33.24%
Ohio	25.99%	26.52%	30.80%	27.77%
Oklahoma	36.73%	30.08%	32.69%	33.16%
Oregon	28.37%	26.44%	29.25%	28.02%
Pennsylvania	27.10%	25.71%	31.68%	28.16%
Rhode Island	-	21.98%	24.89%	23.44%
South Carolina	33.09%	26.29%	34.96%	31.45%
South Dakota	-	31.82%	35.08%	33.45%
Tennessee	30.31%	25.93%	32.33%	29.52%
Texas	24.29%	27.42%	32.43%	28.05%
Utah	31.55%	28.07%	33.66%	31.09%
Vermont	-	24.85%	30.22%	27.54%
Virginia	28.48%	26.78%	30.96%	28.74%
Washington	26.56%	26.53%	29.33%	27.47%
West Virginia	25.90%	26.60%	32.41%	28.31%
Wisconsin	29.64%	28.53%	30.52%	29.56%
Wyoming	-	26.33%	32.39%	29.36%

VITA

Name:	Parth Arora
Address:	Department of Construction Science, Texas A&M University, College Station, Texas 77834-3137
Email Address:	parth.bits@gmail.com
Education:	B.E (Hons), Civil Engineering, BITS Pilani, India