ANALYZING THE MORTALITY RATE IN THE U.S. CONSTRUCTION INDUSTRY (2004 – 2014)

A Thesis

by

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ABSTRACT

Safety remains a major challenge in the construction industry throughout the world. Recent government statistics have revealed a high rate of fatalities in the U.S. construction industry. This study investigates the root causes of this issue and reveals an inverse correlation between mortality rate in the construction industry with respect to time. To address this issue data is gathered from the Census of Fatal Occupational Injuries (CFOI) survey. This survey comprises data that focuses on the reasons for deaths in every US industry. This data is then further categorized into six specific events explained by the Bureau of Labor Statistics. The data was then quantitatively analyzed, with a subsequent statistical analysis in SPSS. Findings show that mortality rates have decreased overall since 2004. This may reflect the fact that there is an improved consistency in safety awareness programs among employers, suggesting that these programs have been effective.

DEDICATION

To my family and friends.

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NOMENCLATURE

BLS	Bureau of Labor Statistics
CFOI	Census of Fatal Occupational Injuries
GLM	General Linear Model
OSHA	Occupational Safety and Health Administration
SLR	Structured Literature Review

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1. INTRODUCTION

According to Koskela and Howell (2002), various factors affect safety to one degree or another. These include each project being one of a kind – a unique prototype; each project is carried out in situ, exposed to the weather and with particular site conditions; and each project is carried out by an assembled team that may be different on each project. These factors may cause strained relations among autonomous agents and therefore, may hamper construction safety on site.

In a construction project, uncertainties are the result of temporary coalitions in a turbulent environment requiring semi-predictable or even unpredictable configurations of supply industries and technical skills (Bertelsen, 2003, 2004, 2005; Bertelsen and Emmitt, 2005). We explore the need to "know why" we build by looking first at the systemic nature and complexity that informs the construction industry's current paradigm. The researcher has analyzed past studies for application of current efforts to improve efficiency and effectiveness; these efforts continue to generate significant differences between expectations and results (Solis, 2008).

Safety is one of the biggest challenges in the construction industry throughout the world (Becerik-Gerber and Siddiqui 2014), because of the indirect costs of poor safety performance (Sampson et al. 2014; Abudayyeh et al. 2006).

Construction work is ergonomically hazardous, commonly requiring numerous awkward postures, heavy lifting and other forceful exertions (Schneider & Susi, 1994). Construction work is also not repetitive in nature. Thus, a high chance and prevalence of work related injuries have been reported in the construction work. Mainly, the mortality rate in the construction industry is about 3 times higher than that for all workers combined (Sorock et al., 1993; Tallberg et al., 1993). This accident analysis is used to recognize the common factors contributing to occupational accidents.

Statistics for construction industry accidents in the U.S. is compiled and maintained by the United States Department of Labor, Occupational Safety and Health Administration. To identify occupational injuries and deaths, the census uses source records, such as workers' compensation reports and employers' accident analysis reports. Information about each occupational death is obtained by cross-referencing multiple sources, such as death certificates, workers' compensation reports, and agency administrative reports. Data compiled by the United States Department of Labor are published annually for the preceding calendar year (Jeong, 1998).

Recent research topics have focused on safety management. These have helped identify ways management practices and policies can help curb injuries in the industry and effectively improve safety performance. Although these have added to the body of knowledge by which construction injuries can be reduced, they have failed to examine the actual field circumstances under which injuries have occurred (Hinze et al., 1998).

This thesis identifies the critical causes when it comes to the high mortality rate in the construction industry, which in turn helps the industry by providing safety countermeasures to tackle these causes. The methodology used is first, a qualitative research method of organizing past studies related to this research objective, and second, a quantitative method to analyze the data received from the BLS. The expected findings should present evidence to support an inverse correlation: mortality rates in the construction industry should decrease over time. The limitations and assumptions of this study are: (1) the study is limited to the North American construction industry; (2) data excludes illness-related deaths unless precipitated by an injury event; (3) data retrieved from BLS is true; (4) falling from height is a major contributor to the mortality rate; and (5) most accidents occurred during temporary construction.

1.1 STRUCTURED LITERATURE REVIEW

1.1.1 CONSTRUCTION INDUSTRY OVERVIEW

The construction industry is one of the largest industries of the United States economy. The Bureau of Labor Statistics (BLS), U.S. Department of Labor, reports that in 2007, the construction industry represented a value of $1,260.128 billion, which is approximately 8% of the total gross domestic product (Forbes and Ahmed 2011). The same report indicates that the construction industry employed 7.614 million people. In a way, the construction industry has been privileged, because competition this industry faces is typically from within the country's borders, whereas the manufacturing industry, service industry and others deal with global competition (Forbes and Ahmed 2011).

Construction fatalities in the U.S. rose to 874 in 2014 from 828 in 2013. The number of fatal work injuries in construction industry in 2014 was the highest reported total since 2008. The fatal injury rate for workers in the private construction industry was 9.5 per 100,000 fulltime equivalent (FTE) workers in 2014 and 9.7 per 100,000 FTE workers in 2013. Heavy and civil engineering construction recorded a series low of 138 fatal injuries in 2014, down from 165 in 2013. The construction industry had the highest number of fatalities amongst all industries for the year 2014 as seen in the chart below. One in five worker deaths in 2014 were in the construction industry.

1.1.2 OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION

Federal OSHA is a small agency; with their state partners, they have approximately 2,200 inspectors responsible for the health and safety of 130 million workers, employed at more than 8 million worksites around the nation — which translates to about one compliance officer for every 59,000 workers. Federal OSHA has 10 regional offices and 90 local area offices. OSHA had a budget of $552,787,000 for the FY 2015.

Since 1970, OSHA has placed emphasis on assuring safe and healthful working conditions for working men and women by setting and enforcing standards and by providing training, outreach, education and assistance. Before OSHA was created 43 years ago, an estimated 14,000 workers were killed on the job every year. Today, workplaces are much safer and healthier, going from 38 fatal injuries a day to 12. OSHA started recordkeeping since 2003 with statistics for worker fatalities, injury, illness etc. According to the statistics gathered from the U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), 4,679 workers were killed on the job in 2014 (3.3 per 100,000 Full Time Employees workers) – on average, almost 90 a week or more than 13 deaths every day. Out of 4,251 worker fatalities in private industry in calendar year 2014, 874 (or 20.5%) were in construction—that is, one in five worker deaths last year were in construction.

OSHA has also created a database to track the most violated standards, which covers not only the construction industry but industry as a whole for the fiscal year 2015. The standards were classified as: (1) fall protection, construction; (2) scaffolding, general requirements, construction; (3) respiratory protection, general industry; (4) control of hazardous energy (lockout), general industry; (5) powered industrial equipment, general industry; (6) ladders, construction; (7) electrical, wiring methods, components and equipment, general industry; (8) machinery and Machine Guarding, general industry; and (9) electrical systems design, general requirements, general industry. (Commonly Used Statistics, 2015).

Recommendations on how the OSHA reports could be made more meaningful are found in the Hinze, Pedersen and Fredley (1998) study. First, injuries should be coded into one of the 20 possible cause categories, rather than the traditional five groups of falls, struck-by, electric shock, caught in/between, and other. Additional or secondary cause codes also were developed. If these cause codes were adopted and used to describe all accidents recorded by OSHA, relevant data retrieval could be more effective.

The leading causes of worker deaths on construction sites were falls, followed by electrocution, struck by object, and caught-in/between. These "Fatal Four" were responsible for more than half (58.1%) the construction worker deaths in 2014, (US Department of Labor, 2016).

Furthermore, the data is classified into following sub-categories for better understanding:

- Falls — 349 out of 874 total deaths in construction in CY 2014

(39.9%)

- Electrocutions — 74 (8.5%)
- Struck by Object — 73 (8.4%)
- Caught in/between — 12 (1.4%) (US Department of Labor, 2016).

Figure 1 below shows us the total deaths in the construction industry in 2014 and the top six causes for those deaths.

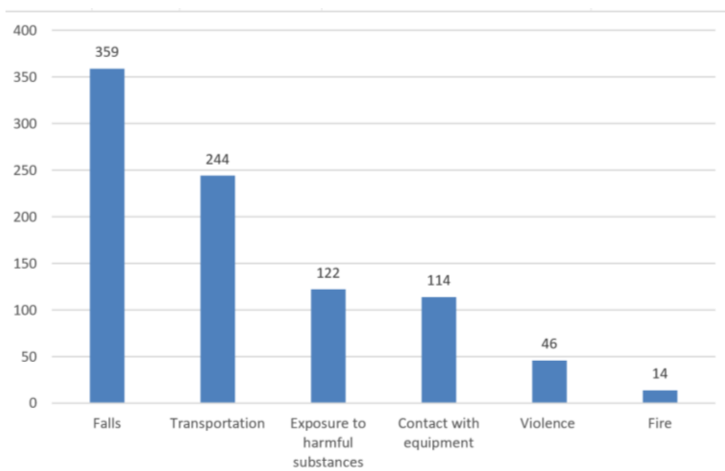

Figure 1. Total deaths in construction industry in 2014. (US Department of Labor, 2016).

Figure 2 on pg. 7, shows the pie chart representation of the top six causes of deaths in the construction industry for 2014.

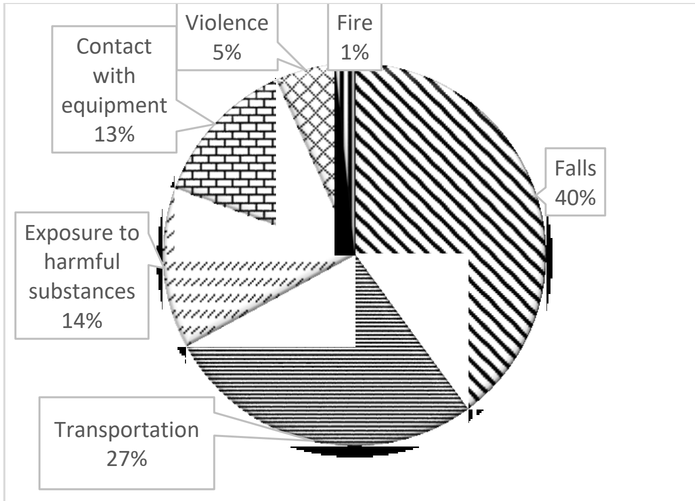

Figure 2. Pie chart representation of total deaths in 2014. (US Department of Labor, 2016).

Work-related falls remain one of the leading causes of death in the workplace (Kisner & Fosbroke, 1994). From 1980 to 1989, the construction industry had the highest annual average rate of deaths resulting from falls with 6.56 per 100,000 workers, according to the National Institute for Occupational Safety and Health (NIOSH, 1993). In 1994, 10.4 % of the 5,923 deaths that occurred in private industry were caused by falls (Bureau of Labor Statistics, 1996). Proportionate mortality ratios identified significantly higher proportions of deaths resulting from falls off ladders in electrical trades and plumbing and heating trades.

One report primarily focused on occupational falls in the construction industry, noting that 87.9% were known to be due to falls from one level to another (Catlledge, Hendricks & Stanevich, 1996). From 1980 to 1989, there were 2798 deaths due to occupational falls in construction, representing 49.6% of all fatal occupational falls across all industries. Most incidents occurred among young white males. In observing the time between the date of injury and the date of death, 66% of the fall victims died on the same day as the injury, whereas 5.7% lived more than 90 days before dying.

A study tried to identify the contributing factors for occupational fatal falls with respect to the victim's individual factors, site conditions, company size, fall site and cause of fall. Individual factors included age, gender, experience, and the use of personal protective equipment (PPE). Accident scenarios were derived from accident reports. Significant linkages were found between causes for the falls and accident events (Chi et al., 2005). Falls from scaffold staging were associated with a lack of complying scaffolds and bodily action. Falls through existing floor openings were associated with unguarded openings, inappropriate protections, or the removal of protections. Falls from building girders or other structural steel were associated with bodily actions and improper use of PPE. Falls from roof edges were associated with bodily actions and being pulled down by a hoist, object or tool. Falls through roof surfaces were associated with lack of complying scaffolds. Falls from ladders were associated with overexertion and unusual control and the use of unsafe ladders and tools. Falls down stairs or steps were associated with unguarded openings. Falls while jumping to a lower floor and falls through existing roof openings were associated with poor work practices (Chi et al., 2005).

The purpose of the Huang and Hinze (2003) study was to identify the root causes of fall accidents and to identify any additional information that might be helpful in reducing the incidence of construction worker falls in the future. While data from January 1990 through October 2001 were examined, particular emphasis was placed on fall accidents that occurred in the last 5 years of this time interval, a period when more data were accumulated and coded in the OSHA investigation reports. Results show that most fall accidents take place at elevations of less than 9.15m (30ft), occurring primarily on new construction projects of commercial buildings and residential projects of relatively low construction cost.

One study presents an analysis of nonfatal (1981 through 1986) and fatal (1980 through 1989) traumatic occupational injuries in the construction industry using the Supplementary Data System and the National Traumatic Occupational Fatalities databases (Kisner & Fosbroke, 1996). The lost workday case rate in construction was 10.1 per 100 full-time workers, which was nearly 2.5 times the occupational injury rate for all industries combined. The construction industry had an overall fatality rate of 25.6 per 100,000 full-time workers. This rate was more than 3.5 times the occupational fatality rate for all industries in the United States for the same period. To prevent occupational injuries and fatalities in the construction industry, intervention measures need to target specific occupations: machine operators, transportation workers, and craftspeople. Intervention measures also need to target such causes of injury as falls, electrocutions, and motor vehicle incidents.

2. RESEARCH METHODOLOGY

The research objective of this thesis is to answer the question: has the mortality rate in the construction industry decreased or increased over time? Another part of the objective is to identify critical causes of deaths in the construction industry. The first step to define this objective was conducting a Structured Literature Review (SLR) to discover similar research, identify a research question, and determine a possible methodology.

2.1 STRUCTURED LITERATURE REVIEW PROCESS

The SLR in the research process focuses on reviewing what others have done in similar areas of knowledge, however, it does not necessarily need to be about the identical topic of investigation. This part of the research describes theoretical and empirical perspectives of previous findings related to the research topic (Leedy & Ormrod 2010). As per (Naoum 2012), the five main steps to conduct an SLR are: (1) identify sources of information; (2) understand how the sources work; (3) collect and review existing publications on the topic; (4) systematically organize the publications; and (5) assess and write up the literature review.

For this study, step (1) involves the publication sources definition: appropriate sources for this specific topic are Google Scholar, The Texas A&M University Libraries, the American Society for Civil Engineers (ASCE) Library, the Engineering Village database, Science Direct, and Pro-Quest Dissertations. These sources would lead the SLR process to papers, books, webpages, and many other types of publications related to the topic.

As part of step (2) in the SLR process, and since all sources are electronic databases, a set of keywords were defined to conduct the investigation using search engines. Keywords used were: Construction, Safety, Accidents in construction industry, Occupational Safety and Health Administration, Labor Statistics, Safety Outcomes, Fatal Falls, General Linear Model.

Step (3) consisted of performing searches in the sources with different combinations of the predefined keywords, which led to the discovery of significant publications regarding the topic. Relevant publications were reviewed and systematically organized as part of step (4). Five rounds of searches with all possible combinations of keywords were performed in the sources to find relevant publications. Step (4) required organizing these publications through a deep review of content and, mainly, the abstracts of these publications. More research papers were identified in the reference sections of the relevant publications, which led to a new set of relevant data. Publications were filtered judging the journal quality, as per the “Journals of Quality” guide provided by the Department of Construction Science at Texas A&M.

Step (5) consisted of creating the writing outline, analyzing publications for each outline item and finally writing up the SLR. The SLR was assessed by the researcher and the committee chair. Findings of the SLR are: (1) identifying and supporting the specific research question; (2) finding no evidence of previous research specifically addressing the research objective; and (3) determining options for the research methodology.

2.2 RESEARCH STRATEGY DEFINITION

As per (Leedy and Ormrod, 2010), there are three main research strategies that are used in academia:

1. Quantitative research
2. Qualitative research
3. Mixed methods research: a strategy that uses qualitative and quantitative means to have a better definition of the research topic, when the use of a single method is not enough. This method provides strengths from one or the other of the basic research methods.

SLR indicates one prevalent similar study using a qualitative approach. However, as this researcher seeks a better outcome of the results and obtaining a more real picture, it was decided to pursue a mixed method research strategy. All qualitative data obtained in the research process, would be analyzed through quantitative methods to provide a greater degree of certainty to the research objective.

2.3 DATA COLLECTION METHOD

The data were collected from the BLS Occupational Injury and Illness Classification System. The data comprises statistics from FY 2004 to FY 2014, gathered from the Census of Fatal Occupational Injuries (CFOI). The data before FY 2004 was not definitive enough and was not based on the categories mentioned below and hence was not used. The CFOI survey focuses on analyzing the reasons for the deaths in every US industry. The data is further categorized into six specific events explained by the BLS: (1)

violence; (2) transportation; (3) fires; (4) falls; (5) exposure to harmful substances; and (6) contact with equipment. The data obtained from the census of fatal occupational injuries is shown in Table 1 on page 16.

2.4 SCOPE OF STATISTICAL ANALYSIS

The data collection was followed by a quantitative analysis, with a subsequent statistical analysis.

The research topic is: To identify whether the mortality rate in the construction industry increased or decreased over time. To answer the main research question through the use of the data from the survey, a quantitative analysis was performed. In the quantitative analysis linear regression and correlation tests were performed which are aimed at understanding how two variables are related to each other. For this, we may consider the variables as X and Y, with Y being the dependent variable and X being the independent variable. In our case, this means Y is the number of fatalities and X is years. We want to know how X influences Y.

Statistical Package for Social Science (SPSS) is the software used throughout the study to perform the statistical analysis. Using SPSS, the data was arranged according to years in descending order. Further, a scatter plot was created from the data, with fatality on the Y-axis as the dependent variable and years on the X-axis as the independent variable. In order to address the topic, we used the scatter plot defined above to see whether the trend line was upwards or downwards. The General Linear Model multivariate analysis was performed, so confidence about the trends was obtained. This test gives us the significance value for every variable which helps us determine how every variable is affected over time.

The null hypothesis for this study is that there is an inverse correlation between the mortality rates in the construction industry with respect to time.

2.5 RESEARCH LIMITATIONS

There are several considerations in the scope of this study, and they directly or indirectly affect the results of this thesis.

- The research focused on the analysis of data gathered from the U.S. construction industry only.
- Data obtained from CFOI survey is assumed to be true.
- It was assumed that the literature available and highly related to this topic is representative of the topic’s understanding.

3. DATA ANALYSIS

3.1 QUANTITATIVE ANALYSIS

A total of eleven years' worth of data was obtained from CFOI and used in the study. We systematically categorized the data in the form of years and their corresponding mortality rates and the reasons for those deaths. The data was formulated in Table 1 shown below for better understanding.

Table 1. Data from Census of Fatal Occupational Injuries. (US Department of Labor, 2016).

Year	Fatality	Violence	Transportation	Fires	Falls	Exposure to harmful substance	Contact with equipment
2104	899	46	244	14	359	122	114
2013	828	36	223	13	302	111	140
2012	806	35	234	9	290	102	136
2011	738	32	197	11	262	112	122
2010	774	30	188	26	264	126	138
2009	834	41	213	14	283	132	151
2008	975	38	241	26	336	132	201
2007	1204	41	296	24	447	182	206
2006	1239	42	323	30	433	191	216
2005	1192	31	318	40	394	164	244
2004	1234	31	287	34	445	179	267

Linear regression and correlation tests were also performed on the dataset using SPSS. The linear regression and correlation tests are aimed at understanding how two variables are related to each other. For this, we may consider the variables as X and Y, with Y being the dependent variable and X being the independent variable. In our case, this means Y is the number of fatalities and X is years. We want to know how X influences Y. Now the basic tool of regression is a scatter plot. This simply plots the data in a graph where X is along the horizontal axis and Y is along the vertical axis. This graph is shown as Figure 3 below.

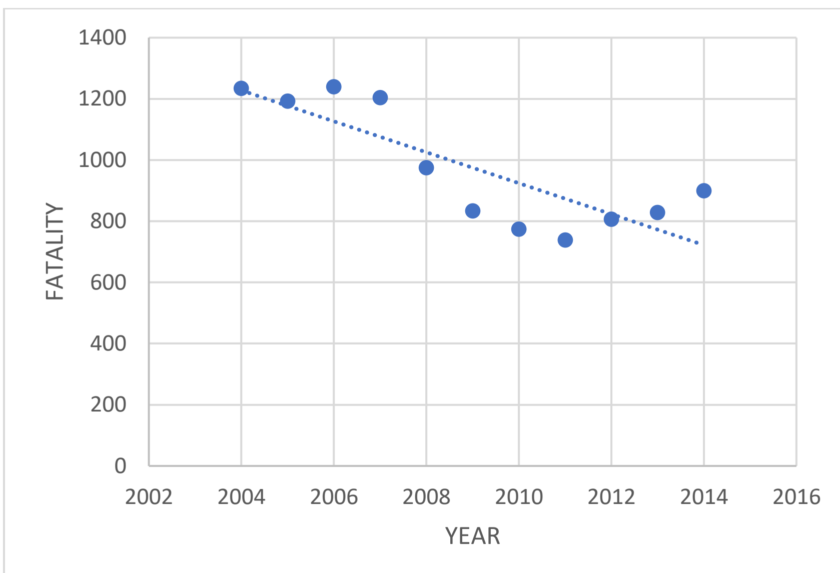

Figure 3. Total fatalities vs year.

Now we need an algorithm to construct the trend line that in some sense best fits the data. So, we use the usual method of least squares, a method that tries to make the squared distance between the line and data as small as possible. From the scatter plot above, we see that the trend may not be linear but it is decreasing. Next, we draw the trend line through the data which gives us the prediction equation. A prediction equation is a line such as, y = c + mx. Here the slope of the line is given by m from the equation. The slope tells us that how much the line changes if we add one unit to the X axis. In the equation given above, c is generally irrelevant because it is where the line happens to go through at X=0. The equation that we get from the scatter plot and from the regression statistics is y = 671.38181 -50.57272x. This translates to the fact that when we add a unit to X axis there is a change of 50.57272 to the trend line and as the trend line is downwards this change is a negative change in the mortality rate as time passes by. Regression output summary is shown in Table 2.

Table 2. Output Summary

Regression Statistics	
Multiple R	0.82967
R square	0.68836
Adjust R square	0.65373
Standard error	118.961
Observations	11

ANOVA	**df**	**SS**	**MS**	**F**	**Significance F**
Regression	1	281336.08181	281336.08181	19.8796	0.0015803
Residual	9	123767.5545	114151.95050		
Total	10	408703.6363			

	Coefficients	**Standard error**	**t Stat**	**P-value**	**Lower 95%**	**Upper 95%**
Intercept	671.38181	76.929112	8.72727	0.0000109	497.3560	845.40756
X	50.57272	11.342578	4.458662	0.0015803	24.914031	76.231423

From Table 2, we get the value for R squared; Pearson correlation is the root of R squared. We get R= 0.8296987 and since the trend line is going downwards, we can interpret that the Pearson correlation is negative. Also, the P-value is 0.001, so the null hypothesis can be rejected with 99% confidence. In other words, we can say with 99% confidence that time affects mortality rates.

3.2 GENERAL LINEAR MODEL

The General Linear Model incorporates normally distributed dependent variables and categorical independent variables. The GLM procedure in SPSS allows us to use the multivariate function. This test gives us the significance value of every variable used, and this number helps us determine a relationship with time for every variable, individually.

From Table 3, on pg. 19 we can say that fatality has a relationship with time because its significance is 0.02 which is <0.05 and the R squared value is 0.654 which means it is highly influenced over a period of time and for that reason we reject the null hypothesis. In other words, 65% of variance can be explained by Total Fatalities. Violence makes no difference over time because the significance is 0.423 and the R Squared value is -0.03 which means it does not make a much of a difference over time and for that reason we cannot reject the null hypothesis. The GLM output is shown in Table 3 below.

Table 3. General Linear Model

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Fatality	281336.082[a]	1	281336.082	19.880	0.002
	Violence	20.945[b]	1	20.945	0.704	0.423
	Transportation	11261.536[c]	1	11261.536	8.983	0.015
	Fire	801.900[d]	1	801.900	27.233	0.001
	Fall	25323.282[e]	1	25323.282	8.247	0.018
	Exposure to Harmful Substance	6802.045[f]	1	6802.045	22.225	0.001
	Contact With Equipment	24810.036[g]	1	24810.036	75.823	0.000

a. R Squared = 0.688 (Adjusted R Squared = 0.654)
b. R Squared = 0.073 (Adjusted R Squared = -0.030)
c. R Squared = 0.500 (Adjusted R Squared = 0.444)
d. R Squared = 0.752 (Adjusted R Squared = 0.724)
e. R Squared = 0.478 (Adjusted R Squared = 0.420)
f. R Squared = 0.712 (Adjusted R Squared = 0.680)
g. R Squared = 0.894 (Adjusted R Squared = 0.882)

From Table 3, Transportation, Fires, Fall and Exposure to harmful substance are all highly significant since their significance values are less than 0.05 and they also have high R Squared values which give us a reason to reject the null hypothesis. Contact with equipment has a significance of 0.000 and a very high R Squared value 0f 0.882 which leads us to the conclusion that you can reject the null hypothesis. In other words, 88% of variance can be explained by the variable Contact with Equipment alone.

A line chart is shown below in Figure 4 which shows us the trend of all the variables over the years as well as to what extent have these variables been significant to the mortality rate of the construction industry.

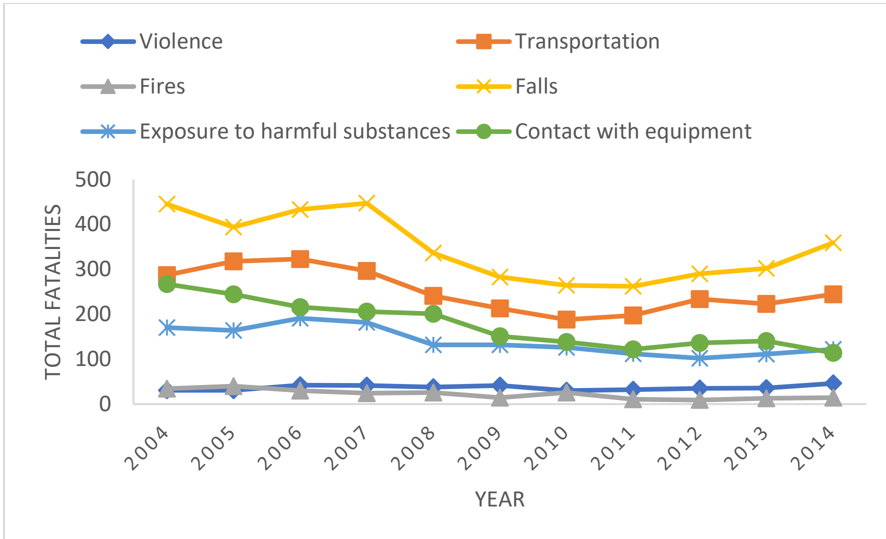

Figure 4. All variables vs year.

From the line chart above, we see that Contact with Equipment has the most significance in bringing the overall mortality rate down, as we can also tell from the R Squared and significance values in Table 3 above. We can also see from the figure above that the variable Violence does not seem to change much over the period of time, which is suggested by the R Squared and significance values. This gives us an added level of confidence in the trend.

4. CONCLUSIONS

4.1 SUMMARY AND CONCLUSIONS

The above results from regression, correlation and the GLM, prove that there is an inverse correlation between the mortality rates in the construction industry and year: mortality rates have decreased over time. Rates of injury and safety events have decreased overall since 2004, so we can say that the construction industry in the U.S. is becoming safer, even though there were more deaths per fulltime employees in the construction industry as compared to other industries in 2014. We can also say that safety programs and other initiatives taken by contractors to keep their workplaces safe seem to be working.

We now know that falling from height has been the major reason behind mortality rates in construction. Contact with Equipment has the most significance in bringing the overall mortality rate down. Violence does not seem to change much over the period of time. The researcher suggests that more research could be carried out in that area in an effort to significantly reduce fatalities in the construction industry.

One limitation of this study can be accounted for by the inherent locality characteristic of safety climate. Although regulations vary by jurisdiction, the globalization of the construction industry and pressure from the public are leading contractors and international firms to use consistent safety practices at all of their sites. Another limitation is that the data is self-reported to BLS, CFOI. Although strict protocols are in place so that employers provide true responses, it is a possibility that some of the responses are incorrect. However, with that being said, the data are very consistent with the findings 10 years ago, so this provides some measure of confidence in the results.

In the methodology section, the main research objective was analyzed through a mixed method research strategy. The data was collected from CFOI for the most recent 10 years. A qualitative analysis was performed on the data, which led to a quantitative analysis using statistical methods. The results from the statistical tests confirmed the trend, which served as the basis to confirm the statement about the main research objective.

The significance of this study is that we are now able to recognize how the 7 listed categories of OSHA and how they are affecting the overall mortality rate. Contact with Equipment and exposure to harmful substances are the variables that have the most significance in bringing the overall mortality rate down. The variable violence does not seem to change much over the period of time and has no significant contribution to the mortality rate over the specified period. This study also allows us to focus now on those categories that are not contributing as significantly to affect the mortality rate and we need to have more studies and research done in those domains of safety and help bring their numbers down.

4.2 FUTURE RESEARCH

Through the development of this thesis, several topics and ideas emerged as raw material to be used by academia for the benefit of the construction industry.

After SLR, the researcher concluded that there is much more information that may be obtained from the data. Next is a list of potential research topics for future research, which could benefit from the data:

1. When will construction industry loose its top spot as the industry with most fatalities as compared to other industries in the U.S.?
2. Future cross sectional studies should be undertaken on a regular basis to track safety performance.
3. Studies in other jurisdictions could provide insight into ways in which regulatory environments affect safety performance.
4. Future research could also focus on benchmarking national and international safety culture indices.

Finally, the next topics for future research came from the SLR process and further analysis:

1. Safety performance in the construction industry (McCabe et al. 2016).
2. Safety culture in construction firms (Abudayyeh et al. 2006).
3. Preventive measures for fatal falls in the construction industry (Chi, Chang & Ting 2005).

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