

Time of Occurrence of Construction Fatalities in Virginia

M. Myung Jeong, Ph.D.
Georgia Southern University
Statesboro, Georgia

Younghan Jung, Ph.D., LEED AP BD+C
Old Dominion University
Norfolk, Virginia

The goal of this study was to investigate the distribution of construction fatalities in Virginia by different time periods. A total of 835 fatal events that occurred in all industry sectors in Virginia from 2000 to 2016 was obtained from the US Department of Labor Data Enforcement. Out of those 835 events, 159 construction-related fatalities were screened for the analysis. The 159 fatalities in construction (19.0%, 159/835) were relatively compared with those in all industries in terms of the time of occurrence by season (spring to winter), month (January to December), weekday (Monday to Sunday), and time of the day (7am to 6pm). It was found that the occurrence of fatalities in construction was overall consistent for the seasonal variation. For the monthly variation, the highest and lowest fatalities occurred in May and April, respectively; for the weekly distribution, the highest on Saturday and the lowest on Sunday; and for the variation within a day, the highest in 3pm-4pm and the lowest in 9am-10am. This study provides a better understanding of construction fatalities compared to other industries from the perspective of time of occurrence specifically in Virginia.

Key Words: Occupational Safety, Construction Safety, Construction Fatality, OSHA

Introduction

For the past several decades, much research effort on construction fatality has been exerted in industry and academia. Surveys, data analyses, and case studies have been carried out to find the interrelationships among various factors in construction such as trade types, working conditions, workers' behavior, work injuries, and the like, hoping to reduce the fatal injuries in construction. Nonetheless, the construction fatalities still accounts for a significant portion compared to the fatalities in other industry sectors according to the Bureau of Labor Statistics (BLS) of the U.S. Department of Labor (BLS, 2017). The BLS reported that the fatal injury rate per 100,000 full-time equivalent (FTE) construction workers in 2016 was found 10.1 which is considerably higher than a national average of 3.6 in all industry sectors in the same year (BLS, 2017).

According to the 2016 statistics released from the BLS, the fatal work injuries in the construction sector takes up 19.1% by count (991 out of a total of 5190 fatal injuries of all industries and governments recorded in 2016) which was the highest level since 2008 (BLS, 2017). The 19.1% fatality or 991 fatal events ranked the 1st by count of the fatal events and ranked the 6th by fatal injury rates per 100,000 FTEs among the 21 major industry sectors and governments. This statistics reminds the practitioners and stakeholders associated with the construction industry that the construction workplace remains unsafe and even hazardous for construction workers in the US. For Virginia in the same year, a similar trend is found: a total of 153 fatal injuries in all industry sectors were recorded accounting for 2.9% (153/5190) out of which fatal events 24 accidents were reported that they occurred in the construction sector (15.7%, 24/153) (BLS, 2018).

The time of accident occurrence is considered an important factor from a safety point of view because understanding the fatality pattern with time is an essential piece of knowledge with which a possible preventive safety action could be taken at the critical time period. Ling et al. (2009) analyzed the time of fatal accidents in construction with Singapore cases by month and day (8am to 6pm). The study found that the fatal accidents are curtailed during rainy season because workers tend to be more attentive, while more accidents occurred in February due to the pressure of workers after a holiday season in Singapore. With respect to the time of occurrence of fatality within a day, it was reported that more accidents occurred around break times. The authors asserted that it could be related to the pressure given to the workers who are in a hurry to finish tasks before break times and catch up after the times (Ling et al., 2009). Other construction safety research have also shown similar results. Huang and Hinze (2003) studied construction fatalities specifically on fall accidents. The time of occurrence analysis in their study indicates that the fall accidents were the highest in July and the major reason could be more intensified construction work activities during summer than other seasons (Huang and Hinze, 2003). In regard to the occurrence of accidents by day of the week and within a day (i.e., hours), the weekly pattern was found uniform overall throughout weekdays but the hourly pattern showed a non-uniform pattern: more accidents before and after lunch time, which is similar to the result by Ling et al. (2009).

It is interesting that the distribution of accidents by time is dependent upon specific construction trades. For example, Arboleda and Abraham (2004) reported that the highest fatalities in trenching operation were observed in May and October, while the occurrence of motor vehicle fatalities in construction were reported being the highest in August (Ore and Fosbroke, 1997). On the other hand, Hinze and Bren (1997) reported the highest frequency of electrical shock in construction was found in October.

Obviously, it will be valuable to look into the number of fatal events by month of year or time of day. It will be also worth looking at the time-related construction fatality patterns in comparison with those of other industries. This paper attempted to analyze the fatal injury accidents in construction by four different time categories by relatively comparing the occurrence of fatalities in each category with other industry sectors, specifically focusing on the Virginia data. The four time categories considered in this study were season (spring to winter), month (January to December), weekday (Monday to Sunday) and the time of day, especially during typical working hour of a day in construction (7am to 6pm).

Research Method

Fatality Data Description

The most comprehensive labor and injury database in the US can be found in the U.S. Department of Labor (Data Enforcement, 2017). As part of the departmental services to the public, this federal agency collects the labor-related data from all US states and US territories and updates the statistics on a regular basis. In particular, the "Data Enforcement" webpage allows users to access OSHA Inspection datasets based on the users' specific needs. The sample dataset used in this study was obtained from the Data Enforcement website (Data Enforcement, 2017), specifically during years of 2000 to 2016 (i.e., 17 years). The webpage offered a wide range of downloadable data options. To meet the objective of this study, the downloaded data was carefully selected with the following conditions: States - "Virginia", Dataset - "OSHA Inspections", Search by - "Year" (2000 - 2016), Accident/Injury - "Show records with accidents/injuries", and Degree of Injury - "Fatality".

During the past 17 years, a total of 835 fatal work injuries considering all industry sectors in Virginia was recorded by Occupational Safety and Health Administration (OSHA). To extract only construction-related cases from the total 835 events, the dataset was further sorted out. The challenge was that the OSHA's description on individual accidents was ambiguous and roughly presented, leading to confusion on whether a certain fatal injury occurred in the construction sector or other industry sectors. For example, one fatal injury in the dataset is described "Employee killed when struck by industrial truck" along with several relevant keywords "Wheel, Industrial, Truck, Sawmill, Struck by, and Logging". Although the description and keywords would enable readers to imagine this deadly situation, it does not provide a clear piece of information on whether it is of construction or other industry and thus remains uncertain (e.g., the accident might have occurred in the transportation sector in this case). To be consistent, therefore, a screening process was conducted to extract construction-related events only by using a "SEARCH" function of a spreadsheet using a keyword of "Construction" in the dataset. The process resulted in 159 fatality events containing the "Construction" keyword out of the total 835 events that occurred in Virginia from 2000 to 2016.

Data Collection

To further sort out the 159 construction fatalities by the four different time categories, the event occurrence date and time information that was included in the original data was used for a sorting-out process for each category. Figure 1 presents a screen shot of sample individual fatal events with each designated time (season, month, weekday, and hour). Based on the time information, the dataset was grouped by each time category. Table 1 shows a sample data set assorted for the weekday category. The numbers in the second and third columns represent the counts of accidents in construction and those in all industry sectors (including the construction data as well), respectively, on each weekday. It is important to understand that the rate of accidents on each weekday shown in the last column was calculated as a rate by comparing accident counts between construction and all industry sectors. In other words, the rate indicates a relative portion of contribution on each time (e.g., In Table 1, accident on Saturday is more likely because the rate, 23%, is higher than the overall average, 19%). Thus, the rate can be used as the major indicator in determining which particular time contributes more to the construction accidents. An average rate of 19.0%, which is based on 159 accidents in construction over 835 accidents in all industries, was used as a threshold. It should be reminded that the rate displayed in Table 1 is not the rate per 100,000 FTEs, rather it simply represents the percentage of the accident counts at a specific time frame over the total 835 fatalities.

	D	E	F	G	H	I	J	O
1	Year	Season	Month	Date	Weekday	Hour		Event Description
2	2000	FALL	OCT	16	Mon	10	AM	Employee Falls 90 Feet from Bridge When Tie-off Fails
3	2000	WINTER	FEB	25	Fri	09	AM	Employee killed in fall through floor hole
4	2000	WINTER	DEC	15	Fri	12	PM	Employee killed in fall from edge of roof
5	2000	WINTER	JAN	12	Wed	01	PM	Employee killed in fall through roof opening
6	2000	WINTER	JAN	28	Fri	02	PM	Employee killed in fall from roof
7	2000	FALL	NOV	02	Thu	02	PM	Employee killed when head crushed under trailer ramp
8	2000	SUMMER	AUG	09	Wed	10	AM	Employee killed when struck by backing trailer
9	2000	WINTER	FEB	03	Thu	10	AM	Employee killed when crushed by steel disc
10	2000	SPRING	APR	11	Tue	10	AM	Employee killed in fall with motorized scaffold
11	2000	SPRING	MAY	03	Wed	03	PM	Employee killed in trench cave-in
12	2000	SPRING	MAY	24	Wed	04	PM	Employee killed in fall through roof opening
13	2000	SUMMER	JUL	25	Tue	10	AM	Employee killed in fall from scaffold
14	2000	SUMMER	AUG	07	Mon	09	AM	Employee killed in fall while installing joists
15	2000	FALL	SEP	11	Mon	04	PM	Employee injured in fall with ladder, dies of septic shock
16	2000	FALL	NOV	01	Wed	07	PM	Employee killed in tunnel collapse
17	2000	FALL	NOV	27	Mon	09	AM	Employee Killed In Trench Cave In
18	2001	SUMMER	AUG	31	Fri	11	PM	Employee killed by fall after electric shock
19	2001	SPRING	MAY	12	Sat	11	AM	Employee falls through hole in floor
20	2001	FALL	OCT	03	Wed	08	AM	Employee is killed when crushed by earthmover bucket
21	2001	SPRING	APR	17	Tue	05	PM	Employee Killed When Struck By Falling Beam
22	2001	FALL	SEP	06	Thu	02	PM	Two employees burned by electric panel fire, one dies

Figure 1: A screen shot of fatality data that sorted out for season, month, weekday, and hour

Table 1

A Sample Table for Time Variation Analysis

Weekdays	Accidents in Construction Only	Accidents in All Industries	Rate
Monday	26	137	19.0 %
Tuesday	31	165	18.8 %
Wednesday	36	182	19.8 %
Thursday	27	139	19.4 %
Friday	21	120	17.5 %
Saturday	13	56	23.2 %
Sunday	5	36	13.9 %
Total	159	835	19.0 %

Results and Discussion

Time of Construction Fatalities

With the fatality counts and rates calculated for each of the four time categories, it was attempted to visualize the trend and characteristic of the designated time windows (e.g., Spring to Winter, Monday to Sunday, and the like) for a relative comparison between the average fatality rate (19.0%) in the construction sector and the individual rate calculated for a specific seasonal, monthly, weekly, and daily period. Figures 2 through 5 depict the comparison by using two vertical axes. The fatality numbers or counts that occurred in both construction and all industries are displayed as a form of a bar chart with the left axis, while the fatality rates in construction at each time window of each category are presented with a form of solid and dotted lines with the right axis. The horizontal solid line in each figure represents the average fatality rate in construction (19.0%) as a threshold. If the fatality rate at a certain time window is higher than the solid line, it can be interpreted that the fatality in that particular time window contributes more to the construction fatal injuries implying that specific time would be more critical to construction workers amongst others.

Seasonal and Monthly Distributions

For a seasonal distribution, the months of March to May were treated as spring in Virginia, and a group of the next three consecutive months thereafter were considered the following seasons (i.e., Summer is months of June to August, etc.). From Figure 2, it is obvious that the fatality counts of all industry sectors are the highest during summer months, and a similar pattern is observed in construction fatalities. It is no surprising that the construction sector has a similar fatality count with other industries as summer is usually the busiest season in any industry sectors. As to the variation of construction fatality rates over the seasons (i.e., the line chart), the trend shows that slightly more fatal accidents occurred during summer and autumn, while the rates in spring and winter are slightly lower. Overall the differences appear very small deviating approximately ±2 percent from the average rate of 19%. This finding suggests that seasonal fatalities in construction generally follows a similar fatality trend that is found in all industries; and no specific season needs to be attentive.

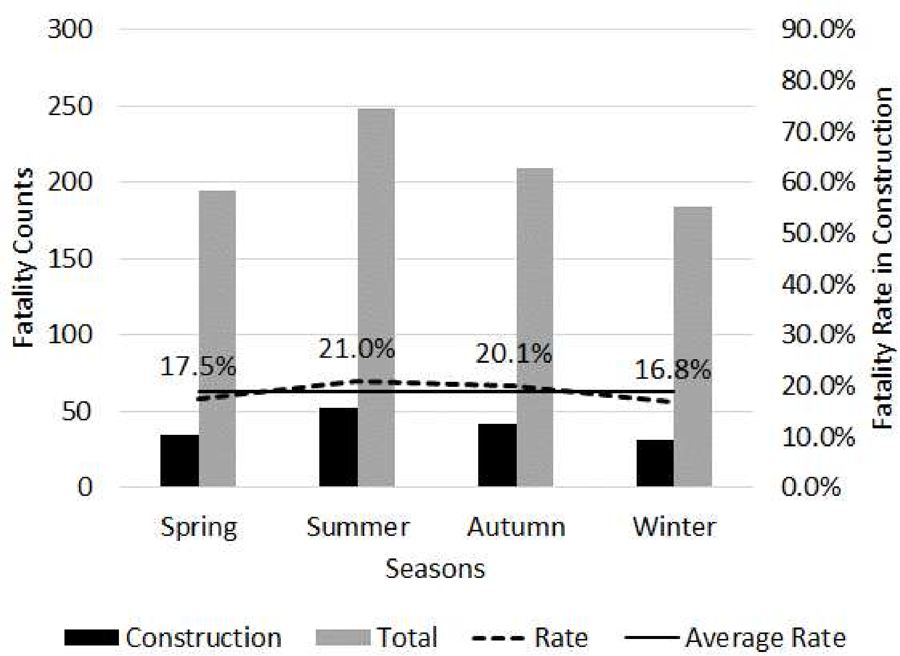

Figure 2: Seasonal distribution of fatality counts and rates in construction

However, when the seasonal data is broken into months of the year, the pattern becomes more distinct. Figure 3 illustrates the fatality pattern by month. The fatality count of all industries has a hike in July with the lowest level in September, while the construction fatality count is the highest in both July and November. This trend are aligned with the finding of a previous study: the highest fatalities during trenching operations in May and October (Arboleda and Abraham, 2004). Note that other previous studies report different months of the year for the highest fatal accidents: July (Huang & Hinze, 2003), August (Ore and Fosbroke, 1997), and October (Ling et al., 2009; Hinze and Bren, 1996). From these slightly different observations, it appears that the highest fatality month in construction depends on other factors such as trade type, regional weather, etc.

With respect to the rate of construction fatalities over months, the month of May (30.0%) contributes the highest, followed by November (25.6%) showing a higher fatal accident rate in these two months compared to the other months. The lowest construction fatalities (8.8%) occurred in April. It is a unique observation that the construction accidents in May and November contribute considerably to the total fatal accidents of all industries. It is reported that a higher frequency of construction accidents is usually attributed to the pressure of finishing work faster and earlier than schedule (Ling et al. 2009; Hinze and Bren, 1996).

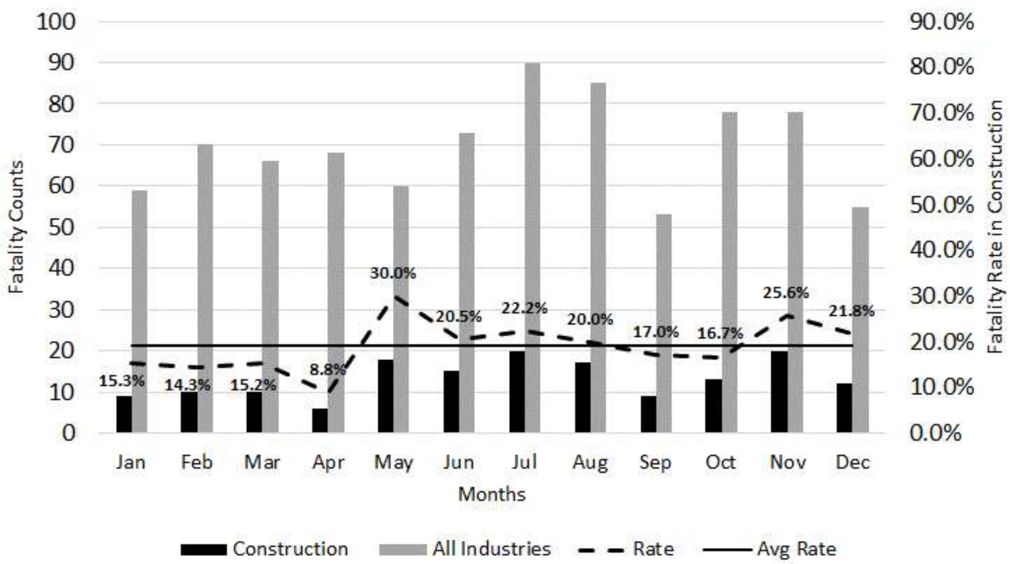

Figure 3: Monthly distribution of fatality counts and rates in construction

Weekly and Hourly Distributions

The weekly trend of fatality counts in all industry sectors indicate that they gradually increase from Monday to Wednesday and drop fast beginning Thursday toward weekends. The construction fatalities also show a similar trend as is clearly seen in Figure 4; the weekly trend of construction fatalities is aligned with that of other industries. The rates of construction fatalities on each weekday are also consistent overall from Monday (19.0%) through Thursday (19.4%) and afterward a slight down change is observed on Friday (17.5%). However, it is also observed that the construction accidents occurred slightly more on Saturday (23.2%) than other industries and less on Sunday (13.9%). This observation may be caused by a different work pattern in construction from other industries. For example, construction workers may work more on Saturday and less on Sunday than those in other industries.

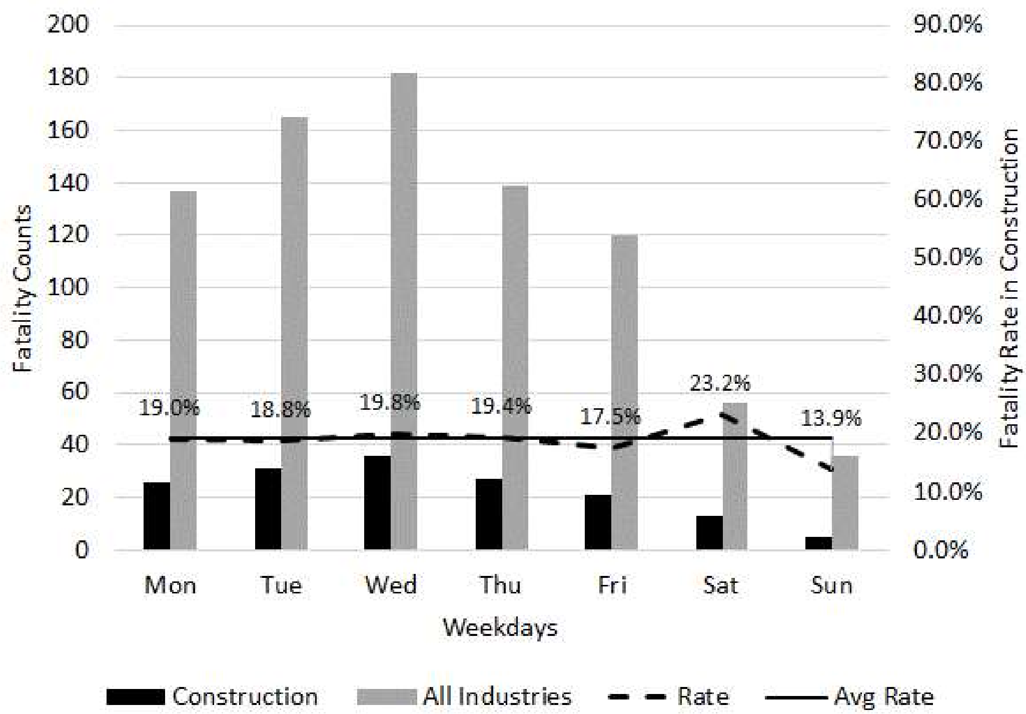

Figure 4: Weekly distribution of fatality counts and rates in construction

As for the hourly distribution within a day, the accident counts in construction seem to follow a similar trend as those of other industries as shown in Figure 5. The accident count has a peak around 11am-12pm and is curtailed right after lunch time. Afterward, the counts go up and down till 4pm-5pm. Overall, it is observed that, by count, the occurrence of accidents in construction appears higher immediately before and after the lunch break (11am-1pm). However, the rate shows a different pattern. Before and after the break, the rates are higher (23.4% around 12pm-1pm and 25% around 2pm-3pm) than the average, indicating the accidents in construction are more than those in other industries around these time windows. From 1pm-2pm to 3pm-4pm, the rate steeply goes up and reaches the peak point (27.1%) in the 3pm-4pm time window. This trend was found and reported in other previous research. The possible reasons to explain the trend are:

- Workers receive pressure by supervisor to finish a job before break time; simultaneously they tend to feel pressure to catch up after break time (Ling et al., 2009)
- Workers' physical tiredness and fatigue are highest before break time that would cause the loss of concentration of work (Ling et al., 2009)
- Construction materials are inattentive during break and they may become a different condition that workers are unaware of (Arboleda and Abraham, 2004)
- Workers are under the influence of alcohol after the consumption during lunch time (Lopez et al., 2011)

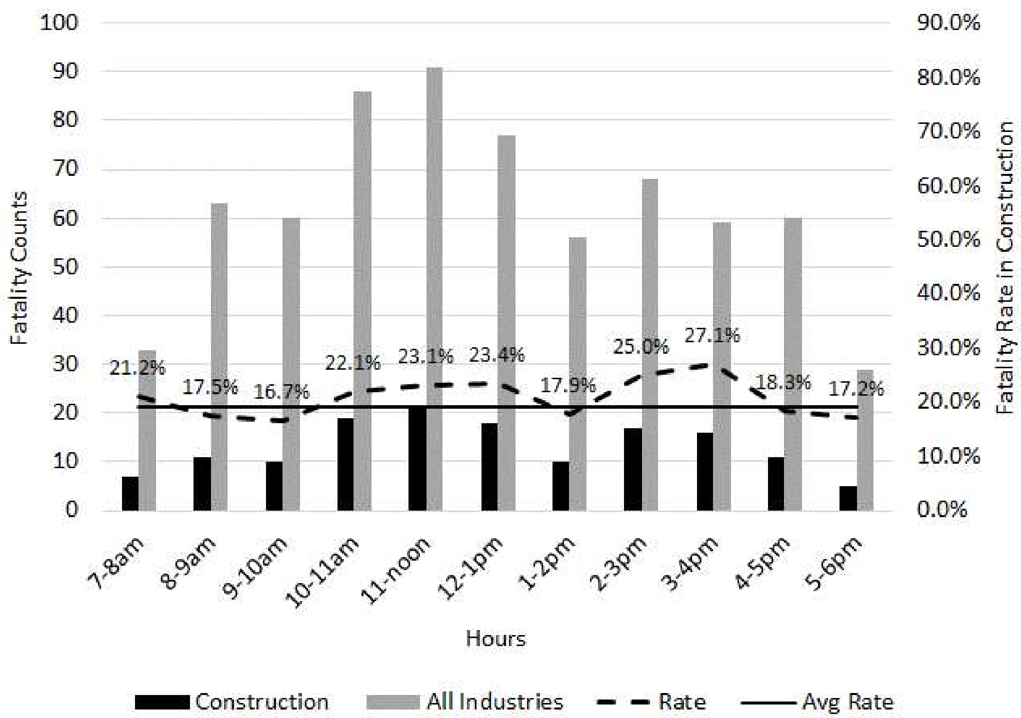

Figure 5: Hourly distribution of fatality counts and rates in construction

Summary and Conclusion

This study explores the fatal accidents in construction in comparison with those in other industries in Virginia, based on 835 fatal accidents that occurred in all industries during 2000 and 2016. Of the 835 fatalities, 159 construction-specific cases were drawn for a relative comparison with respect to time of occurrence of fatalities. The summary of major findings are:

- As for the seasonal variation, the construction accidents follow the trend of accident occurrence of other industries. In summer, the construction fatalities are slightly higher in summer and lower in winter as compared to other industries. Overall, no significant seasonal variation is observed.
- As for the monthly variation, it is observed that the construction fatalities are a lot higher in May and November than those of other industries. The lowest fatalities are found in April.
- The weekday variation in construction fatalities is found almost uniform from Monday to Thursday, though a slight decrease is observed on Friday. The construction fatalities are the highest on Saturday and the lowest on Sunday than other industries.
- The hourly distribution of occurrence of accidents in construction shows a similar trend of other industries by count. However, the rate of accidents in construction around lunch time contributes more than other times. The highest accident rate is found between 2pm and 4pm.

While it is important to identify casual factors of construction accidents, it is also worth looking into time of occurrence. The critical times that are found in this study would suggest that a more vigorous safety management be required for the times. For example, an additional set of safety inspections by supervisors before and after break times of the day would avoid fatal accidents. It is also recommended that safety education to construction workers include the fact that more accidents tend to occur during the critical times.

This study is limited to the fatality data in Virginia. There might be a biased result reported in this study that could be only meaningful to this specific region. In order to generalize the findings, future research including the fatality data reported in other states is necessary.

References

Arboleda, C. A. & Abraham, D. M. (2004). Fatalities in Trenching Operations - Analysis Using Models of Accident Causation. *Journal of Construction Engineering and Management, 130 (2)*, 273-280.

Bureau of Labor Statistics. U.S. Department of Labor. (2017). *National Census of Fatal Occupational Injuries in 2016* (USDL-17-1667). Washington D.C.

Bureau of Labor Statistics. U.S. Department of Labor. (2018). *Fatal Occupational Injuries in Virginia-2016* (18-960-PHI). Washington D.C.

Data Enforcement, U.S. Department of Labor. (2017, October 15). Citing online sources. [WWW document]. URL https://enforcedata.dol.gov/homePage.php

Hinze, J. & Bren, D. (1996). Analysis of fatalities and injuries due to powerline contacts. *Journal of Construction Engineering and Management, 122 (2)*, 177-182.

Hinze, J (1997). *Construction Safety*. New Jersey: Prenice-Hall.

Huang, X. & Hinze, J. (2003). Analysis of construction worker fall accidents. *Journal of Construction Engineering and Management, 129 (3)*, 262-271.

Ling, F. Y. Y., Liu, M., & Woo, Y. C. (2009). Construction fatalities in Singapore. *International Journal of Project Management, 27 (7)*, 717-726.

Lopez, M. A. C., Fontaneda, I., Alcantara, O. J. G., and Ritzel, D. O. (2011). The special severity of occupational accidents in the afternoon: "The lunch effect". *Accident Analysis and Prevention, 43 (3)*, 1104-1116.

Ore, T., & Fosbroke, D. E., (1997). Motor vehicle fatalities in the United States construction industry. *Accident Analysis & Prevention, 29 (5)*, 613-626.