

THE IMPACT OF FATIGUE ON THE SAFETY PERFORMANCE OF CONSTRUCTION  
WORKERS: A LONGITUDINAL STUDY

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**ABSTRACT**

In the construction industry, workers are constantly exposed to hazards such as chemical exposures, falls from heights, and accidents involving large machinery. Construction sites contribute to generating threats to human life and property, making safety a priority. When safety is taken as a serious matter, accidents, fatalities, and property damage can be avoided. The performance of construction workers impacts projects and determines their quality and success in achieving project goals. In construction sites, an indicator for measuring safety performance is the safety attitude, which is understood as the individual's attitudes and actions towards the workplace. Several factors can affect a worker's safety attitude, one of these factors is Fatigue. This study aimed to analyze the impact of fatigue on safety performance in construction workers.

To collect information, eighty workers were interviewed over eight weeks. The data collected were analyzed using a linear regression model, repeated ANOVA analysis of variance, and Friedman's rank sum test. Most significantly, the analysis revealed a correlation between the three scales used to measure fatigue (OFER, CIS, and FAS). Due to this correlation between scales, the investigation continued only with the analysis of the OFER scale. Further analysis, using linear regression models, showed a strong relationship

between safety attitude and the OFER scale. As a result, Safety attitude significantly predicted fatigue levels in the construction workers. On the other hand, results showed that fatigue did not affect safety attitude, but safety attitude affected fatigue, at least for short periods.

In conclusion, a worker's attitude in reaction to workplace safety might be influenced by a high number of variables, amongst these variables fatigue is our focus. Simultaneously, it is critical to comprehend additional aspects to build a safer workplace. The results of this study highlight the significance of encouraging a safety attitude culture at work, as this can have a big impact on workplace safety. The report also recommends that fatigue management programs must be introduced in the construction sector to enhance safety and lower the hazards related to fatigue.



Impact Of Fatigue on The Safety Performance of Construction Workers: A Longitudinal Study

A Thesis

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## DEDICATION

To my mother, who has always supported me and encouraged me to fulfill my dreams.

To my dad, who guides me from heaven and inspired me to continue with my professional career.

To my lovely wife, who always believed in me.

And to my friends, who always encourage me to continue.

## ACKNOWLEDGEMENTS

I would like to thank Dr. Mostafa Namian, who supported me, advised me, and believed in me from the beginning of this journey and who also inspired me to be a better person.

I would like to thank Daniel Godwin, who helped me with the data collection, and without that, it could be impossible to complete this investigation.

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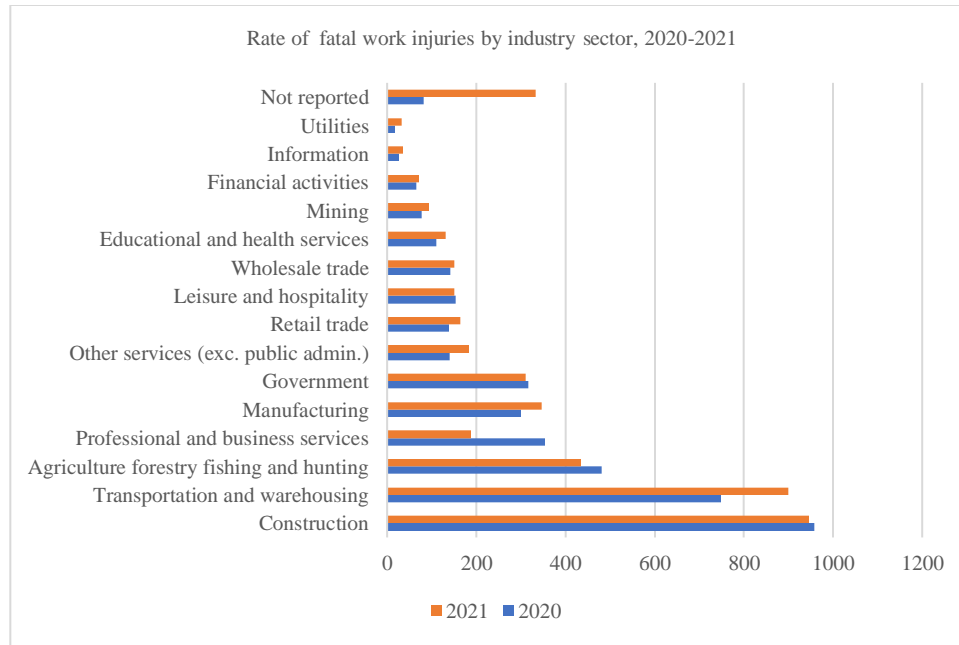
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## CHAPTER 1: INTRODUCTION

### Background

The number of injuries and deaths in the construction sector, one of the largest businesses in the world, exceeds all other industries each year (OSHA 2018). In many wealthy and developing nations alike, the rate of accidents has been high (Namian et al., 2021). In 2018, 20% of work-related mortalities were related to the construction industry in the European Union, the highest number of other industries (Namian et al. 2021). Another example is China. According to Xu, Q., & Xu, K. (2021), China has more than 6000 deadly accidents in the construction industry in the decade between 2010 and 2019, it counts for 7275 fatalities during this year, around 727 per year.

In the US, less than 7% of the workforce is employed in construction, however, this industry counts for one out of five fatalities at construction job sites (OSHA 2018). Moreover, construction has the higher number of avoided fatal injuries in 2021, followed by transportation and warehousing (National Safety Council. n.d.). Figure 1 shows the number of fatal work injuries per industry in the EE.U.



*Figure 1 Rate of fatal work injuries by private industry sector in 2021 and 2022. (National Safety Council. n.d.)*

A final and most recent example is necessary to rise. As mentioned in the article by the Guardian called “Revealed: 6,500 migrant workers have died in Qatar since World Cup awarded” the 2022 Qatar World Cup had at least 6,500 worker fatalities since they were given the World Cup in 2010. (Taylor, 2022) Most of the construction fatalities were by migrants coming from countries like Pakistan, Nepal, and Bangladesh. Nevertheless, the number of fatalities could be meaningfully higher because these numbers are excluding the death toll from other several countries, like Kenya or the Philippines. (Taylor, 2022). This situation mainly occurs because the Qatari population is around 4 million habitants, and most of their labor force comes from other countries. (Taylor, 2022) Also, construction workers who participated in the construction of this event were forced to work under extreme conditions and factors such as extreme heat, long hours of shift, and Fatigue. (Taylor, 2022)

Leading indicators were mentioned in past examples. Recognizing the leading indications is essential to preventing these large numbers in the construction sector. Other indicators of safety performance include safety attitude, safety risk perception, or hazard recognition(Namian et al., 2021). Investigators have conducted studies that have shown that most construction accidents can be attributed to different factors that impact safety performance. One of the most mentioned factors in several studies is fatigue, which has been deemed an important cause of accidents in construction places. (Zhang et al., 2015)

Fatigue is a common feeling, and it is the result of mental or physical tiredness, or simply not having enough time to recover from activities. When fatigue levels are high, cognitive abilities decrease, processing, control, and reactions are weakened, and responses to new information are less effective(Abd-Elfattah et al., 2015). Motivation, alertness, work capacity and quality, and productivity also reduce. Fatigue increases the risk of accidents and physical strength problems, judgment, and the temptation for unsafe behaviors in the workplace(Zhang et al., 2015). In other words, increased fatigue can potentially lead to a catastrophic accident.

### Rationale of the research

Some leading indicators affect the safety performance of the construction workers, for example, safety attitude. Also, some factors affect safety performance like Fatigue, but no one has talked about the connection between fatigue and safety attitude.

The goal of this investigation is to analyze the impact of fatigue on the safety attitude of construction workers. To achieve this goal, a longitudinal study combined with a series of analyses will be conducted to analyze the possible relationship between safety attitude and fatigue. The hypothesis of this research is:

## **Hypothesis 1**

Null: Higher levels of fatigue do not lead to lower safety attitude levels among construction workers

Alternative: Higher levels of fatigue lead to lower safety attitude levels among construction workers

This research intends to benefit construction workers and how their perceptions and natural feelings could intervene in their performance. Safety coordinators, construction companies, and professors in construction areas can obtain new insights into fatigue and safety attitude's impact on the industry of construction.



## CHAPTER 2: LITERATURE REVIEW

The goal of this research was to investigate the impact of fatigue on the safety performance of construction workers. To accomplish this objective and change the lagging indicators, which do not predict, is necessary to review past studies to analyze the leading indicators such as safety performance. Also, a review of fatigue, safety attitude, and past limitations is essential to understand how this study can be approached.

Past studies in safety performances have used objective and subjective methods to measure fatigue levels. For example, in recent years, there have been several research technologies to identify construction hazards through an objective method. This method includes collision detection sensors (Park et al. 2016) or devices that detect falls or slips (Kim et al. 2017). Another example was conducted by Elshaer and colleagues (2019) in which they measure the heart rate variability through a 12-lead ECG device. The purpose of this investigation was to measure fatigue after performing a treadmill exercise.

Moreover, past studies have used subjective methods to measure safety and fatigue. As an example, a study in 2019 by Lee and colleagues (2019) had the purpose to measure the safety attitude through a survey in Korea. Another example was a study by Eslami and colleagues (2021) in which they used the multidimensional fatigue inventory (MFI) to measure Iranian construction workers' fatigue.

On the other hand, a small sample of participants has had a common issue in past studies. This issue can be important because it could reduce the precision of the conclusions at the time of the study. For example, an investigation by Larsen and colleagues (2019) had fewer than 20

participants in their study. They were investigating how cumulative fatigue affected the physical performance of construction workers.

### Safety attitude

According to Huang et al. (2020), safety attitude can be described as an important predictor of safety performance. It indicates that the successful development of a construction project will be related to a positive safety attitude. Also, a safety attitude is considered an important factor in safety performance. For example, Biggs et al. (2007) mention that some attitudes are important to determine if a workplace is safe or not.

Safety attitude can be described as three components based on the work and studies by Triandis (1980), and Eagly and Chaiken (1993). These authors classify safety attitudes into the affective component, the cognitive component, and the behavioral component. First, the affective component is based on emotional reactions and can be shaped by past experiences. Second, the cognitive component mainly reflects the beliefs of a person about a situation or an object. Finally, the behavioral component reflects how a person may act in front of an object or situation. (Loosemore & Malouf, 2019)

Some studies have discovered the impact of safety attitude on safety performance. For example, in a study by Sardar and Sahu (2020), it was found that safety performance was highly affected by the safety attitude of the employees. Another study (Loosemore & Malouf, 2019) found that there was a relationship between safety attitude and safety performance in males and females after a training course.

In conclusion, safety attitude can be broken down into 3 components and these components can affect the construction workers' response to construction hazards.

## Fatigue

Fatigue is one of the most common feelings that people experience often throughout their life. (Windwood et al. 2006). It also can be defined as the desire to recover after physical or mental activities, illnesses, or tiredness. (Williamson et al. 2011). In a study by Zhang and Yu (2018), it was discovered that fatigue can be attributed as an important factor in accidents in construction.

According to Chan (2011), fatigue can affect the reaction and response of construction workers, which means that the probability that an accident occurring is higher. Also, fatigue can affect how a worker reacts to a safety procedure, increasing the tendency to risk and decreasing the ability to react to hazards (Lingard et al 2015). Moreover, Fatigue is generally classified into different dimensions. For example, fatigue can be classified as acute or chronic and it can usually treat with rest or sleep (Namian et al., 2021).

To summarize, fatigue is an important factor that affects the safety performance of construction workers. It can reduce cognitive abilities and reaction times. Also, fatigue can influence the safety attitude by decreasing the capacity to react and recognize hazards on the construction site.

## CHAPTER 3: METHODOLOGY

### Research Method & Design

This thesis is part of fatigue research under the supervision of Dr. Mostafa Namian, for which numerous data were collected mainly by Daniel Godwin and Daniel Garay. Presented data in this thesis were collected by Daniel Godwin. The data collected by Daniel Garay will be used for future research. The principal purpose of this chapter is to outline the proposed research methodology for data collection methodology, including instruments or scales, and the type of analysis. The following steps are considered for the methodology:

- Locate a group of people related to the construction industry, willing to collaborate with the investigation throughout 8 weeks.
- Conduct a longitudinal study with the selected group and use a series of instruments to measure safety attitudes and fatigue levels.
- Analyze the data collected after the longitudinal study is complete and corroborate the hypotheses established at the beginning of the study.

A demographic questionnaire is essential to have a context of the background, conditions, and attitudes of participants. The questions for this part of the study are age, gender, years of experience in construction, education background, previous training, and current job title.

In addition, the multidimensional scales: The occupational fatigue exhaustion recovery (OFER), The checklist individual strength questionnaire (CIS), and the fatigue assessment scale (FAS) will reveal more detailed information about fatigue and performance relationships in the construction area. The questionnaire used during the first week is attached in APPENDIX A.

## Procedure

Studies that follow people over a long period use continuous or recurring measures and are usually defined as longitudinal studies (Caruana et al., 2015). These studies are often observed in nature, with any combination of exposures and results being recorded using quantitative and/or qualitative data without the use of outside influences (Caruana et al., 2015). The advantages of longitudinal research are numerous. One of the benefits of this method is the capacity to recognize events and link them to exposures, another benefit is to track changes over time in specific cohort members (Caruana et al., 2015). However, it also has several drawbacks, including the inability to distinguish between the reciprocal effects of exposure and result, interrupted follow-up of individuals due to many circumstances, and more.

## Population And Sample

For this investigation, 80 construction workers related to the construction were approached. It included equipment operators, laborers, carpenters, foremen, project managers, designers, and more. They were asked to complete a survey that includes more than 80 questions during the first week. However, for the following seven weeks, they were asked to answer around 45 questions due to the correlation between the three fatigue scales (OFER, CIS, FAS) used during the investigation. The questionnaire used after week 1 is attached in APPENDIX B.

## Ethical Consideration

As mentioned previously, the IRB approved this quantitative study, and procedures for safeguarding human participants were taken into consideration throughout the study - from planning to data analysis. The data was collected in site with an online questionnaire using Qualtrics. The survey did not require any identifying or personal information from participants, only a name to be able to track the participant, which ensured their anonymity and

confidentiality. Furthermore, the study presented a minimal risk to participants as they were not exposed to any type of harm such as physical or psychological. Participation in this investigation was voluntary and participants had the opportunity to continue at any time. A copy of the approval letter is attached as APPENDIX C.

### Instruments

#### The Occupational Fatigue Exhaustion Recovery Scale (OFER)

This is a subjective way to measure fatigue. This questionnaire was developed by Dr. Sharon Toker and Colleagues in 2012. This scale was designed to measure fatigue levels into three through a set of 15 questions. (Winwood et al. 2005). OFER-15 questionnaire includes three dimensions: chronic fatigue (C.F.) (five items) which includes questions such as “I often feel I’m at the end of my rope’ with my work”, acute fatigue (A.F.) (six items) includes questions like “After a work shift, I have little energy left”, and recovery between work shifts (5-items) that include questions like “I never have enough time between shifts to recover my energy completely”. (Winwood et al. 2005).

OFER scale has been not used in construction. For example, a study with ambulance workers by Reis and colleagues (2017) found that high fatigue levels were associated with low health levels. It means that the risk of an accident increased. Another example is a study to measure the levels of occupational fatigue in firefighters.

### The Checklist Individual Strength (CIS)

In 2000, Beurskens and Bultmann developed a questionnaire called “The Checklist Individual Strength (CIS)”. It is used as a tool to measure the level of fatigue and related symptoms in individuals. It contains 20 items divided into four sub-scales such as subjective feelings of fatigue, physical activity, concentration, and motivation. The questionnaire has been widely used in various populations to evaluate fatigue levels and their impact on everyday routines. This instrument includes questions like “I feel very tired”, “I feel very active” or “I feel rested”.

To validate the CIS questionnaire's reliability and validity, some studies have been made. One of these studies was executed by Smets et al. (1995). It assessed the psychometric properties of the CIS questionnaire in a group of people with cancer, they found that the questionnaire gave them the ability to differentiate between patients with and without fatigue. Elfering et al. (2010) used the CIS questionnaire to assess the level of fatigue among nurses. Also, they found that the questionnaire was reliable and valid to discern between nurses with and without fatigue.

### The Fatigue Assessment Scale (FAS)

This is a questionnaire that includes 10 items and assesses the level of fatigue and how it affects social, occupational, and daily functioning. The items of the FAS include physical, cognitive, and affective components of fatigue, including tiredness, lack of energy, difficulty concentrating, and irritability. (Chalder,T at al. 2002)

Zhang et al., 2021, used FAS to assess fatigue in workers of healthcare during the pandemic 2020 and found that healthcare workers reported high levels of fatigue, which was associated with lower job satisfaction, higher stress levels, and lower resilience. Moreover, Saraf

et al., 2021 used the FAS to assess fatigue in shift workers and found that shift workers reported higher levels of fatigue than day workers, which was associated with levels of work-family conflict (High) and levels of job satisfaction (low).

### Safety attitude scale

Loosemore, M., & Malouf, N. (2019) synthesized literature and created a questionnaire covering both demographic and non-demographic questions relating to safety attitudes. Demographic questions focused on respondent age, gender, education, experience, and previous safety training. The non-demographic questions were created and used to evaluate three components of safety attitude towards safety: the affective, cognitive, and behavioral components. Responses were obtained using a seven-point Likert Scale to minimize acquiescence bias. Certain questions were phrased negatively to ensure that respondents did not simply agree with all questions. The questionnaires were administered and collected on-site and data collection took place over eight weeks.

### Data Analysis

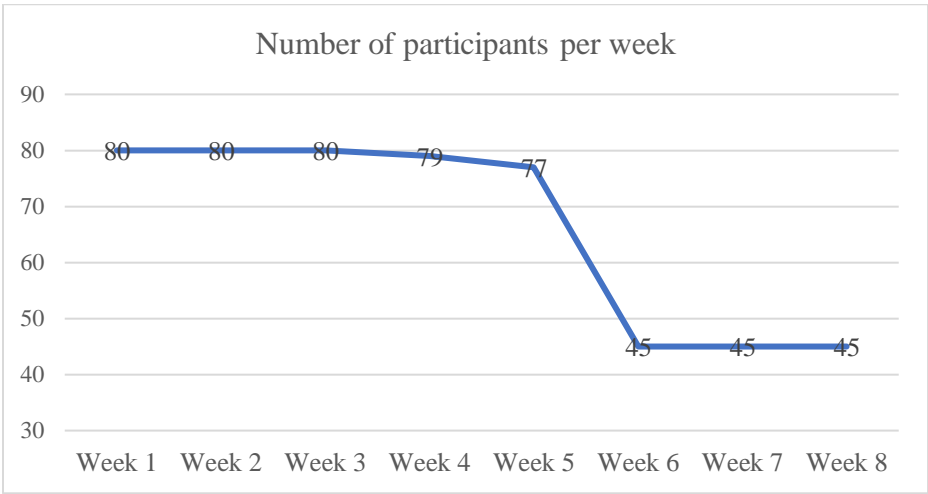
The data file of the survey was downloaded through Qualtrics. The initial analysis showed the correlation between OFER, CIS, and FAS. Linear regression analysis was used to test the correlation between safety attitude and fatigue. The difference of group means was analyzed with the repeated analysis of variance ANOVA and the Friedman Rank Sum Test as an alternative. All the analyses were carried out in IBM SPSS 25 and the demographics were through Microsoft Excel



# CHAPTER 4: RESULTS AND DISCUSSION

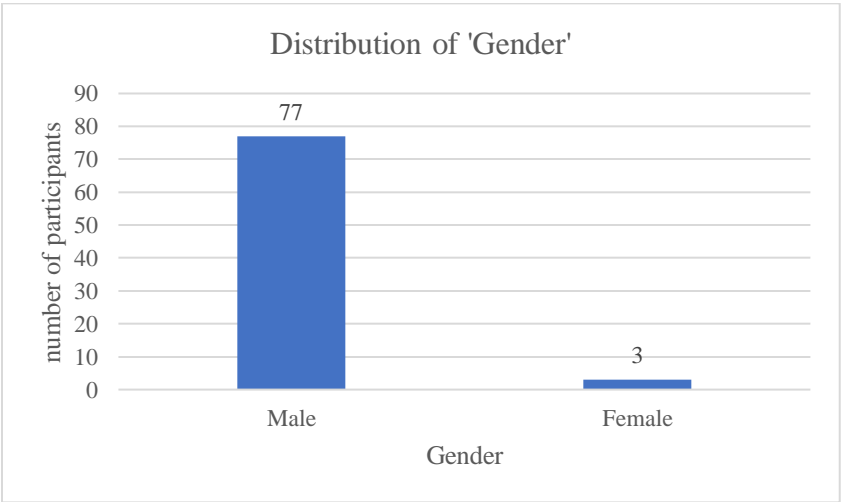
## Demographics

During the first 5 weeks, we were able to collect data from 80 participants. However, because time in the construction industry is very limited, we ended up collecting data from 45 participants in the last 3 weeks. (Figure 2)



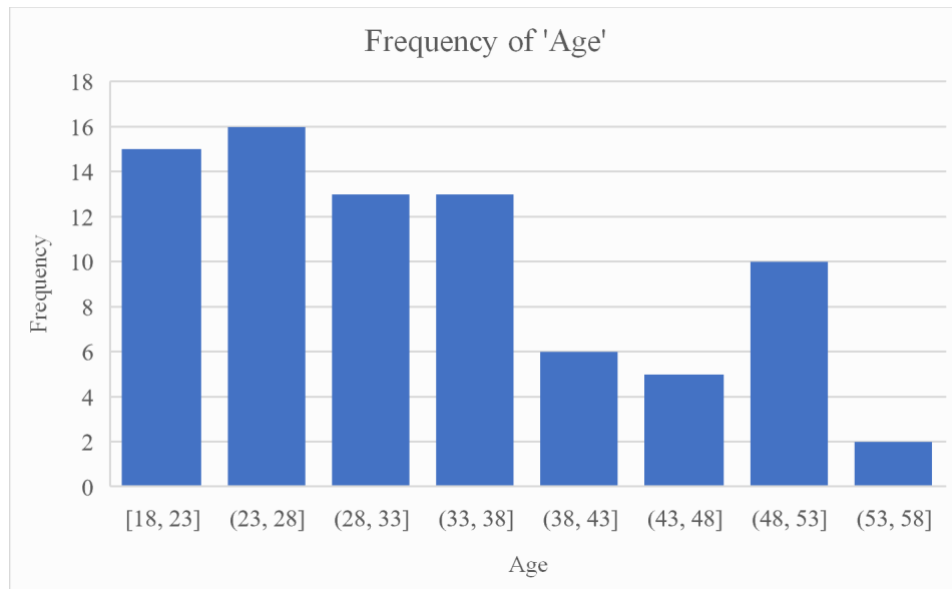
*Figure 2 Number of participants per week*

The group of construction workers was predominantly males and only 3 females participated in the investigation.



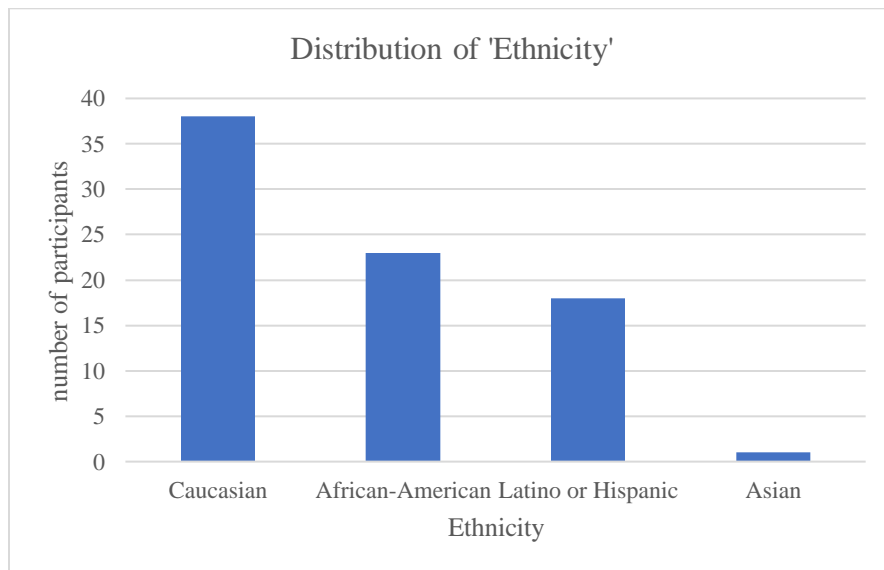
*Figure 3 Participant's Gender Results*

The group included ages from the early twenties to fifties, a big portion of the group ages were between their twenties and thirties.



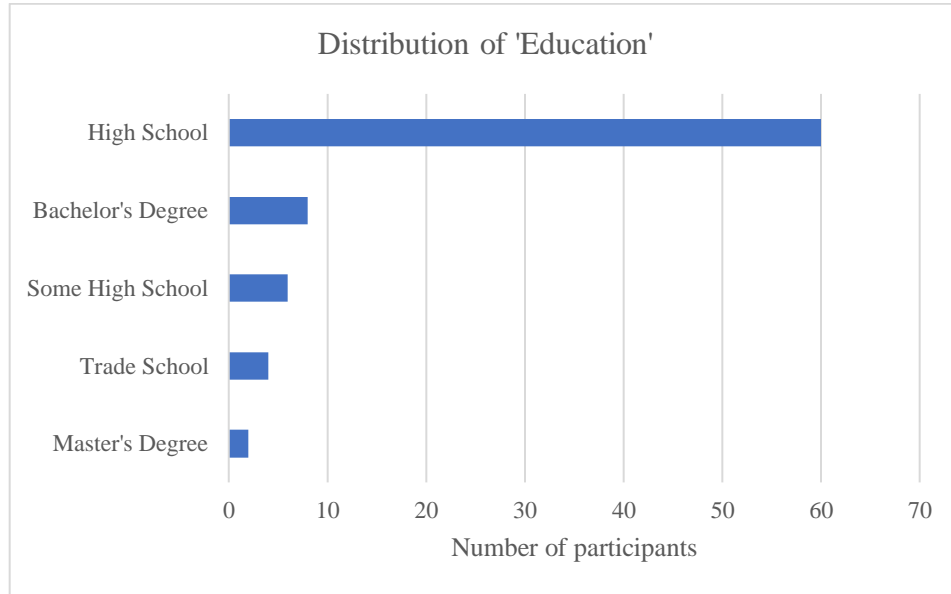
*Figure 4 Participant's Age Results*

Many participants were Caucasian. However, a significant number of participants belong to another ethnicity such as African American, Latino or Hispanic, or Asian.

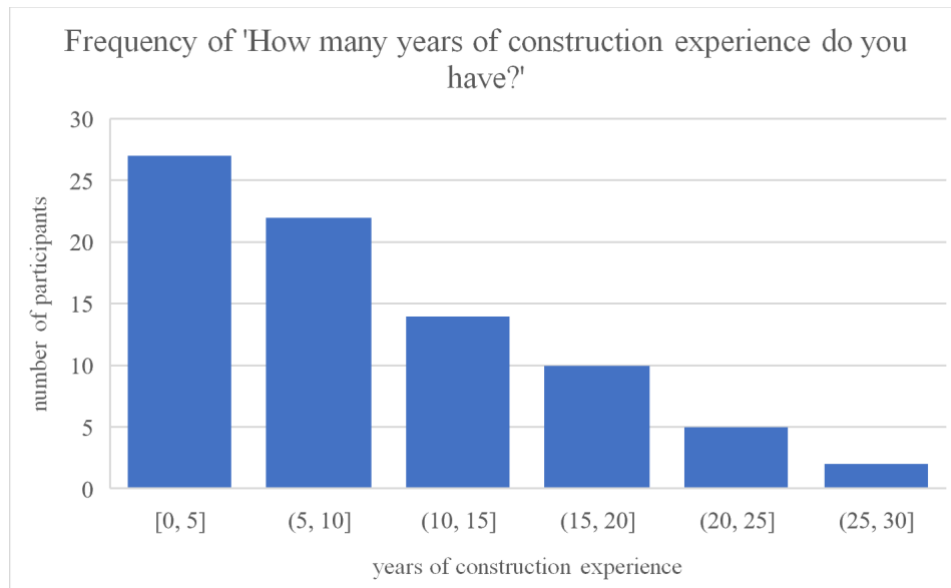


*Figure 5 Participant's ethnicity results.*

Most of the population in this study had their high school as their educational background. On the other hand, in terms of years of experience, most of the participants were just starting their carrier in the construction industry.

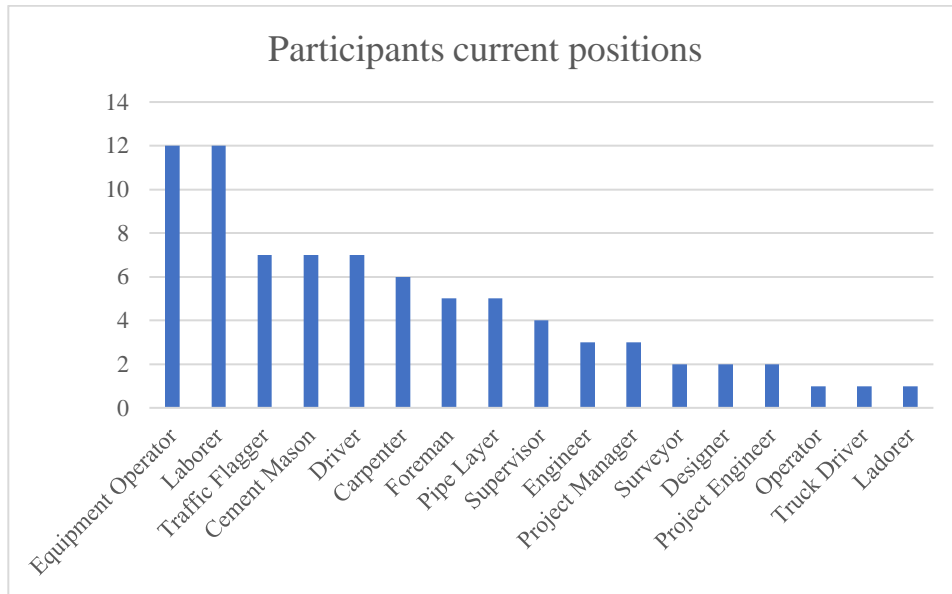


*Figure 6 Participant's Education results*

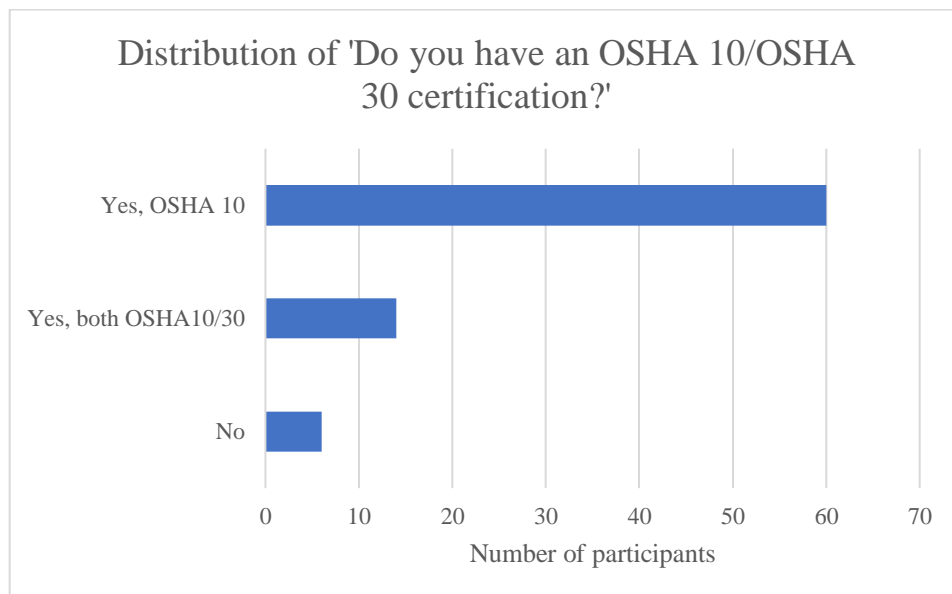


*Figure 7 Participant's years of construction results*

The positions with the highest number of workers were laborer and equipment operator, as the lowest numbers were for workers in the truck drivers force and other types of operators. Most of the participants had previous training in OSHA 30.



*Figure 8 Participant's current positions results*



*Figure 9 Participant's OSHA 10/30 results*

The results also show that most of the participants did not have an accident during the past twelve months.



*Figure 10 Injure in participants in the last 12 months results.*

To find the impact between Fatigue and safety attitude, a series of analyses have to be conducted. First, a correlation between the three scales (OFER, CIS, FAS), was performed to identify if the coming analysis were possible by using only the results of one of these scales. The results Table 2 shows that there is a correlation between the three of those and the graphs in Figures 10,11 and 12 confirm this information.

	CIS	FAS	OFER
CIS	1	0.97	0.89
FAS	0.97	1	0.89
OFER	0.89	0.89	1

*Table 1 Correlation between CIS, FAS, and OFER*

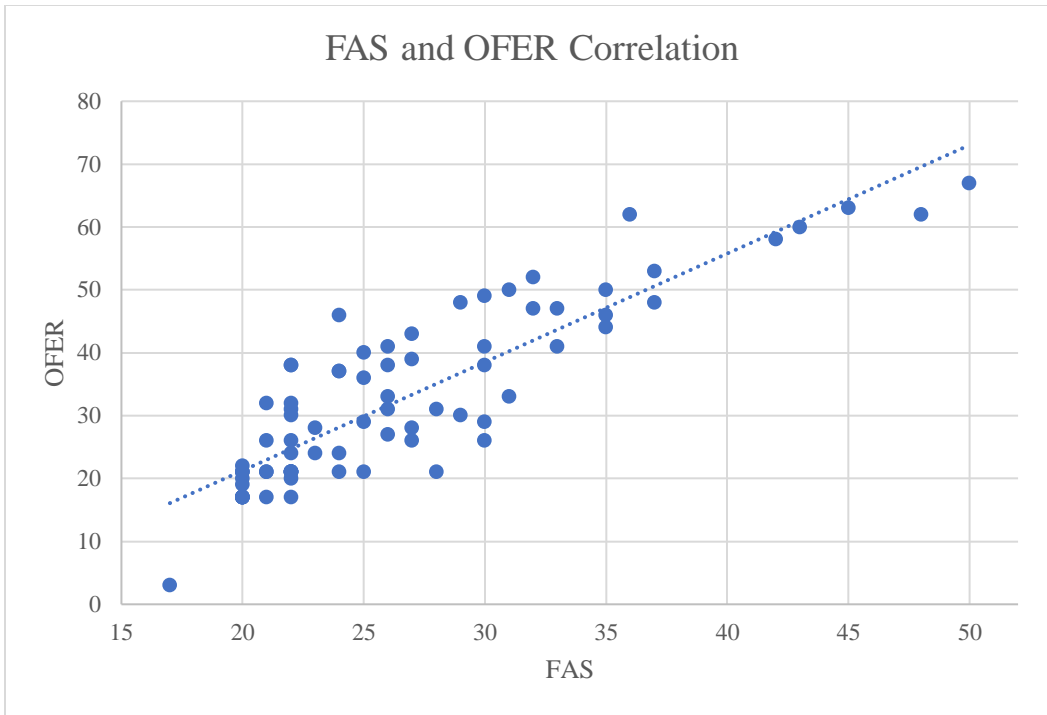


Figure 11 Correlation between FAS and OFER

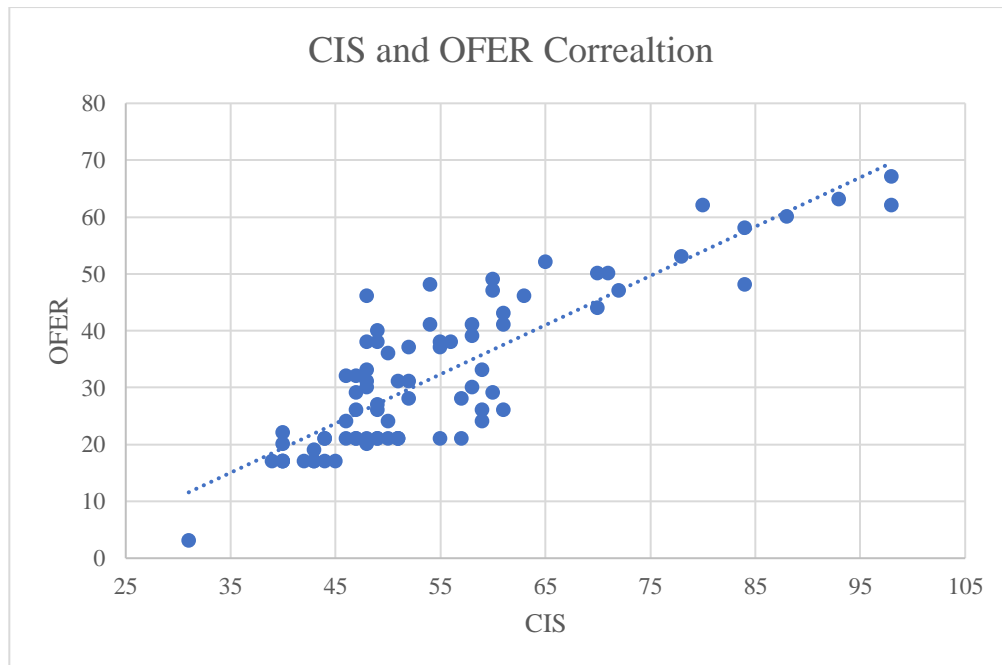
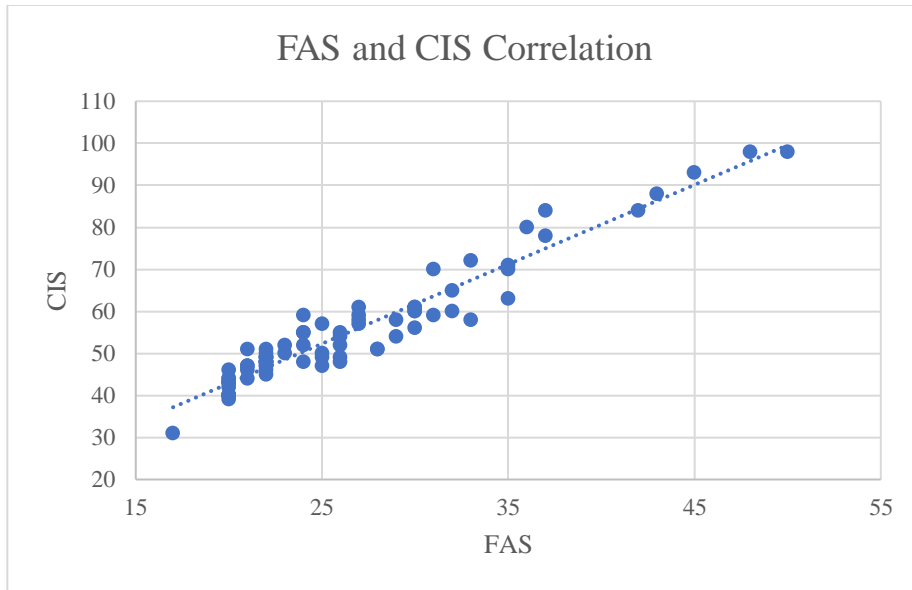


Figure 12 Correlation between CIS and OFER



*Figure 13 Correlation between FAS and CIS*

Second, linear regression was performed. For this analysis, the results of OFER and safety attitude per week were analyzed.

Linear Regression Analysis

Results for Week 1

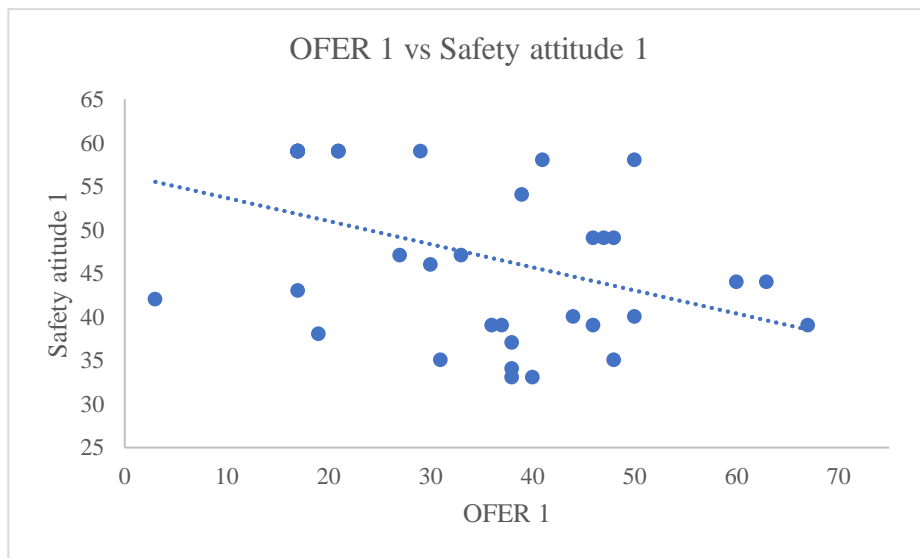
To analyze if safety attitude will significantly predict OFER in week 1, linear regression analysis was directed. The results of the model were significant, demonstrating that Safety Attitude may account for roughly 11.65% of the variance in OFER for week 1. This shows that a one-unit rise in Safety will typically result in a 0.007-unit drop in the value of OFER. Table 3 recapitulates the results of the model.

*Table 2 Safety\_Attitude1 predicting OFER\_Total1 Linear Regression results.*

Variable	<i>B</i>	<i>SE</i>	95.00% CI	$\beta$	<i>t</i>	<i>p</i>
(Intercept)	0.64	0.10	[0.44, 0.83]	0.00	6.46	< .001
Safety_Attitude1	-0.007	0.002	[-0.01, -0.003]	-0.34	-3.21	.002

*Note.* Results:  $F(1,78) = 10.28, p = .002, R^2 = .12$

Unstandardized Regression Equation:  $OFER\_Total1 = 0.64 - 0.007 * Safety\_Attitude1$



*Figure 14 Linear regression analysis between OFER 1 and Safety Attitude 1*



Results for Week 2

To analyze if safety attitude will significantly predict OFER in week 2, linear regression analysis was directed. The results of the model were significant, demonstrating that Safety Attitude may account for roughly 15.71% of the variance in OFER for week 2. This shows that a one-unit rise in Safety attitude will typically result in a 0.008-unit drop in the value of OFER.

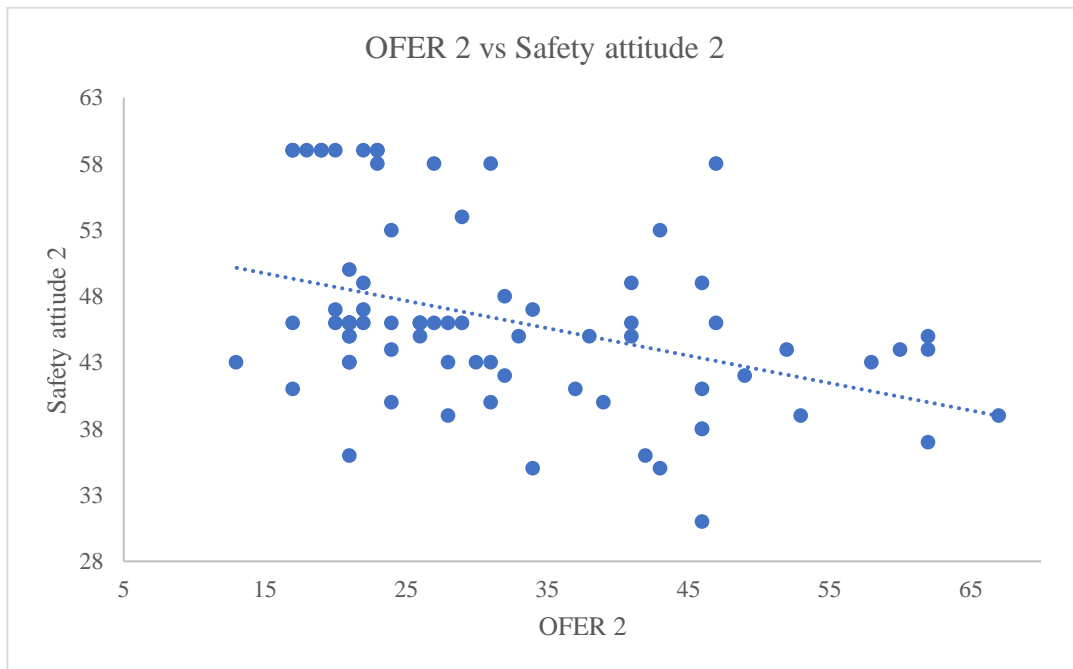
Table 4 recaps the results of the model.

*Table 3 Safety\_Attitude2 predicting OFER\_Total2 Linear Regression results.*

Variable	B	SE	95.00% CI	$\beta$	t	p
(Intercept)	0.67	0.09	[0.48, 0.85]	0.00	7.15	< .001
Safety_Attitude2	-0.008	0.002	[-0.01, -0.004]	-0.40	-3.81	< .001

*Note.* Results:  $F(1,78) = 14.53, p < .001, R^2 = .16$

Unstandardized Regression Equation:  $OFER\_Total2 = 0.67 - 0.008 * Safety\_Attitude2$



*Figure 15 Linear regression analysis between OFER 2 and Safety attitude*

Results for Week 3

To examine how OFER will be predicted by safety attitude in week 3, a linear regression analysis was conducted. The outcomes of the model were important, demonstrating that Safety Attitude may account for roughly 8.54 % of the variance in OFER for week 3. This shows that usually, a one-unit rise in Safety attitude will result in a 0.007-unit drop in the value of OFER.

Table 5 summarizes the results of the regression model.

Table 4 Safety\_Attitude3 predicting OFER\_Total3 Linear Regression Results

Variable	B	SE	95.00% CI	$\beta$	t	p
(Intercept)	0.66	0.12	[0.41, 0.90]	0.00	5.32	< .001
Safety Attitude 3	-0.007	0.003	[-0.01, -0.002]	-0.29	-2.70	.009

Note. Results:  $F(1,78) = 7.29, p = .009, R^2 = .09$

Unstandardized Regression Equation:  $Ofer\_Total3 = 0.66 - 0.007 * Safety\_Attitude3$

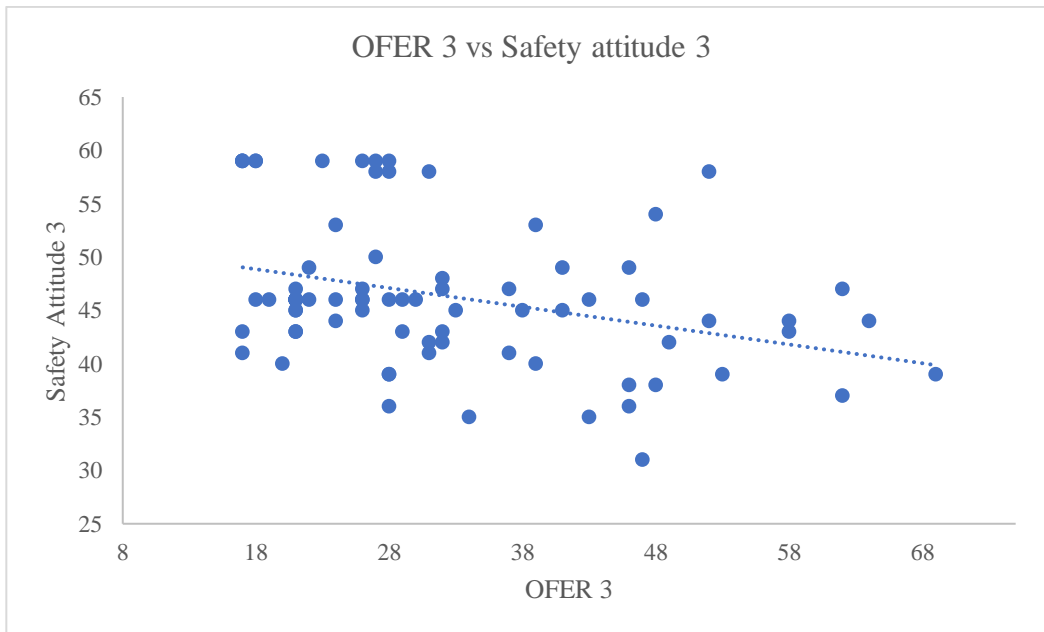


Figure 16 Linear regression analysis between OFER 3 and Safety Attitude 3

Results for Week 4

To analyze if safety attitude will significantly predict OFER in week 4, linear regression analysis was directed. The findings of the model were significant, demonstrating that Safety Attitude may account for roughly 11.60 % of the variance in OFER for week 4. This shows that a one-unit rise in Safety attitude will typically result in a 0.009-unit drop in the value of OFER.

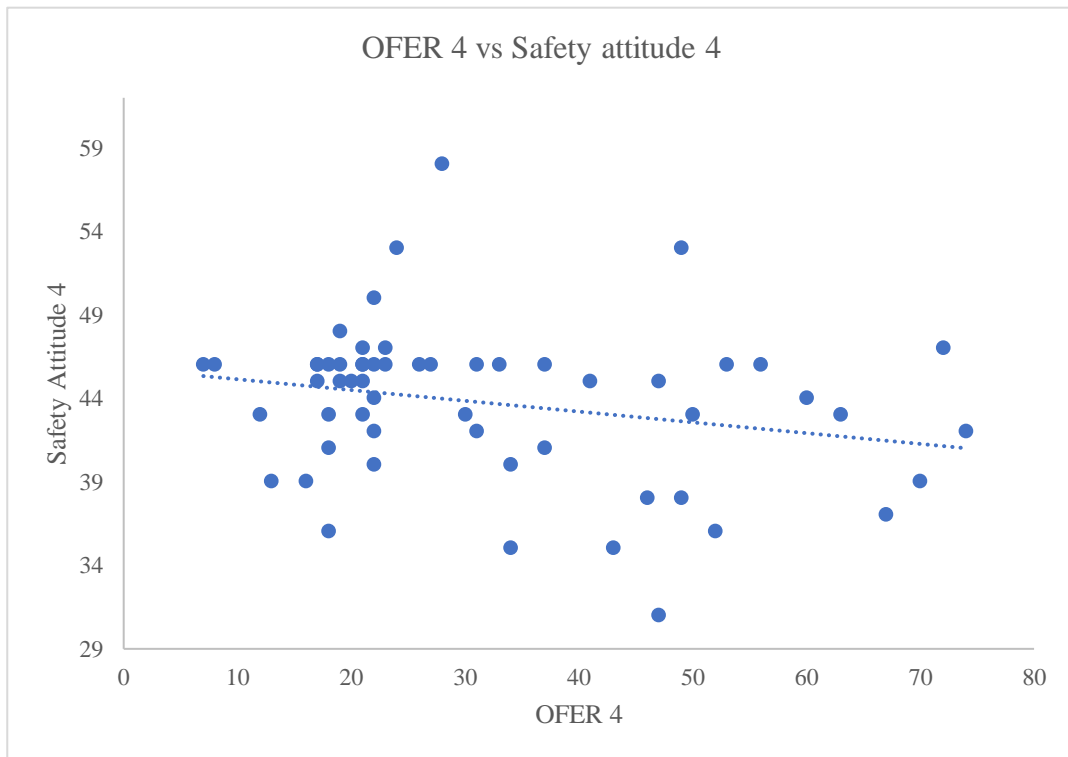
Table 6 recaps the results of the model.

*Table 5 Safety\_Attitude4 predicting OFER\_Total4 Linear Regression Results*

Variable	B	SE	95.00% CI	$\beta$	t	p
(Intercept)	0.73	0.13	[0.46, 0.99]	0.00	5.49	< .001
Safety_Attitude4	-0.009	0.003	[-0.01, -0.003]	-0.34	-3.18	.002

*Note.* Results:  $F(1,77) = 10.10, p = .002, R^2 = .12$

Unstandardized Regression Equation:  $OFER\_Total4 = 0.73 - 0.009 * Safety\_Attitude4$



*Figure 17 Linear regression analysis between OFER 4 and Safety Attitude 4*

Results for Week 5

To analyze if safety attitude will significantly predict OFER in week 5, linear regression analysis was conducted. The findings of the model were significant, demonstrating that Safety Attitude may account for roughly 11.20 % of the variance in OFER for week 5. This shows that a one-unit rise in Safety attitude will typically result in a 0.009-unit drop in the value of OFER.

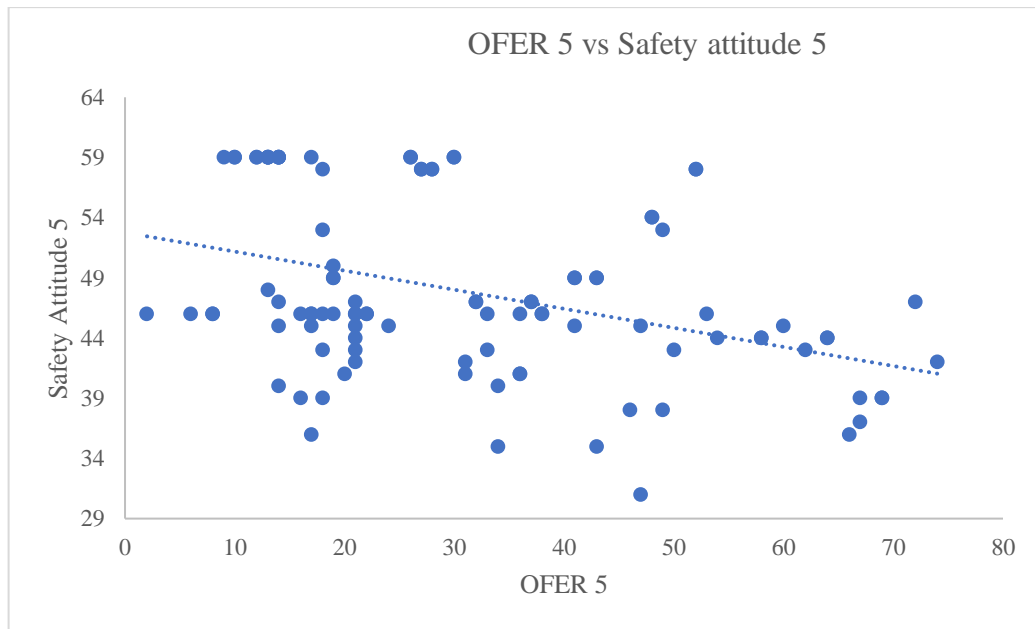
Table 7 recapitulates the results of the regression model.

*Table 6 Safety\_Attitude5 predicting OFER\_Total5 Linear Regression Results*

Variable	B	SE	95.00% CI	$\beta$	t	p
(Intercept)	0.69	0.13	[0.42, 0.96]	0.00	5.17	< .001
Safety_Attitude5	-0.009	0.003	[-0.01, -0.003]	-0.33	-3.08	.003

*Note.* Results:  $F(1,75) = 9.46, p = .003, R^2 = .11$

Unstandardized Regression Equation:  $OFER\_Total5 = 0.69 - 0.009 * Safety\_Attitude5$



*Figure 18 Linear regression analysis between OFER 5 and Safety Attitude 5*

The results for 5 weeks showed that is a correlation between safety attitude and fatigue.

However, to analyze which of the two variables is affecting the other, repeated analysis of variance ANOVA led to analyzing the alteration of the results during the 5 weeks.

Repeated analysis of variance ANOVA

This analysis is based on the mean, and it was executed to analyze the change in the safety attitude levels and fatigue levels during the five weeks. The results of this analysis for safety attitude levels were scrutinized based on an alpha of .05. Since the within-subjects factor had no significant main effect, the values of safety attitude were consistent over the five weeks. Table 8 presents the results of the analysis. The means of the within-subjects factor are presented in Table 9 and Figure 18.

*Table 7 Safety results for Repeated Measures ANOVA.*

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>	$\eta_p^2$
Within-Subjects						
Within Factor	4	1.23	0.31	1.79	.181	0.02
Residuals	308	52.95	0.17			

*Table 8 Means Table for Within-Subject Variables for Safety.*

Variable	<i>M</i>	<i>SD</i>
Safety_Attitude1	46.23	7.03
Safety Attitude2	46.37	6.86
Safety Attitude3	46.36	6.87
Safety_Attitude4	46.35	6.87
Safety_Attitude5	46.39	6.86

*Note. n = 78.*

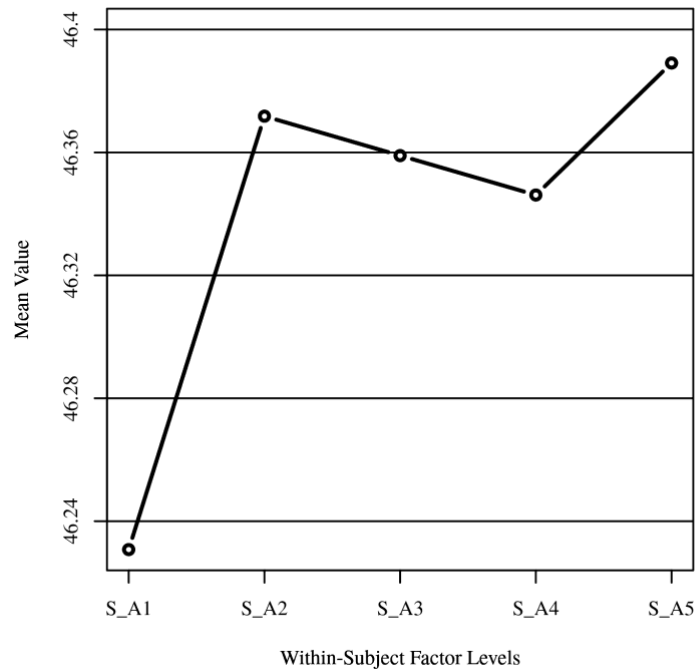


Figure 19 Within-subject variable means safety attitude.

The results of the repeated analysis of variance ANOVA for fatigue were examined based on an alpha of .05. Since the within-subjects factor had a significant main effect, the values of OFER were inconsistent over the five weeks. Table 10 presents the results of the analysis. The means of the within-subjects factor are presented in Table 11 and Figure 19.

Table 9 OFER Results: Repeated Measures ANOVA

Source	<i>df</i>	<i>SS</i>	<i>MS</i>	<i>F</i>	<i>p</i>	$\eta_p^2$
Within-Subjects						
Within Factor	4	0.07	0.02	4.46	.015	0.06
Residuals	304	1.18	0.004			

Table 10 Means Table for Within-Subject Variables for OFER

Variable	<i>M</i>	<i>SD</i>
OFER_Total1	0.32	0.13
OFER Total2	0.31	0.12
OFER Total3	0.32	0.16
OFER_Total4	0.30	0.17
OFER_Total5	0.28	0.18

Note.  $n = 77$ .

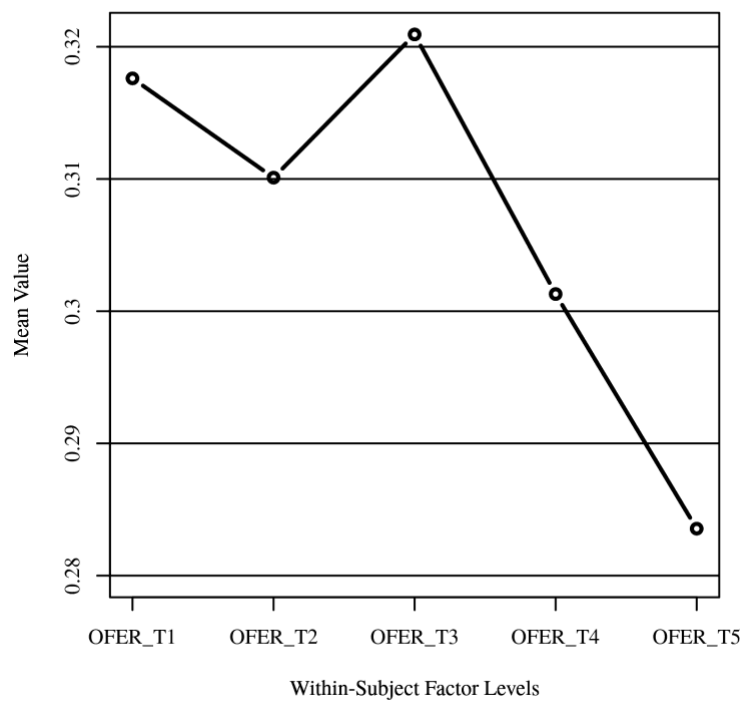


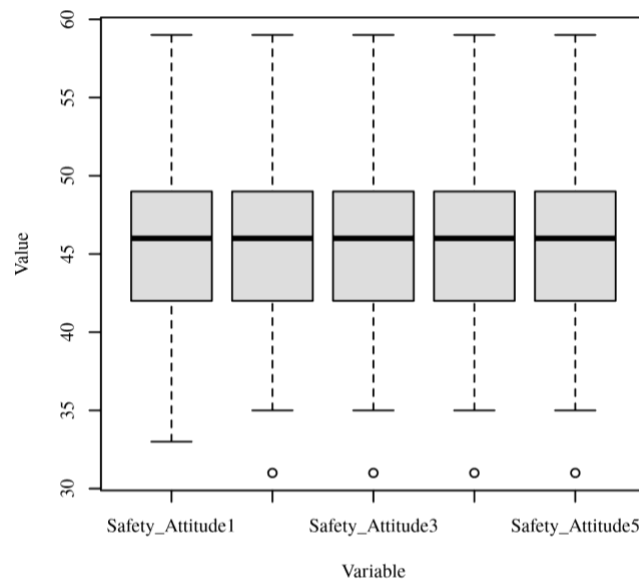
Figure 20 Within-subject variable means OFER.

## Friedman Rank Sum Test

As an alternative to the repeated variance of analysis ANOVA, A Friedman rank sum test was conducted to examine whether the safety levels were the same or varied during the 5 weeks based on the medians. Based on an alpha value of .05, the results of the test for Safety attitude were not significant. It means that there is not any variance in safety attitude during the five weeks. Table 12 Results of the Friedman rank sum test. Figure 20 Safety attitude boxplots.

*Table 11 Safety attitude: Friedman Rank Sum Test*

Variable	Mean Rank	$\chi^2$	df	p
Safety_Attitude1	2.87	6.67	4	.155
Safety_Attitude2	3.06			
Safety Attitude3	3.03			
Safety Attitude4	3.00			
Safety_Attitude5	3.03			



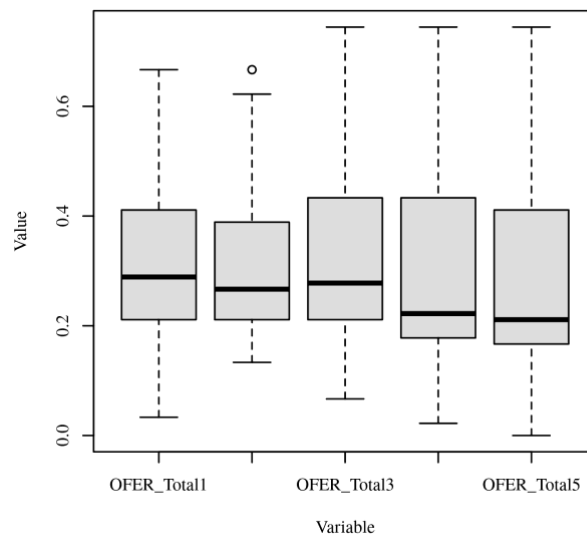
*Figure 21 Boxplots of Safety Attitude for weeks 1, 2, 3, 4 and 5*



Moreover, Another Friedman rank sum test was led to also examine whether the medians of OFER were equal or different for the 5 weeks. Based on an alpha value of .05, the results of the test were significant. This indicates that there is a difference in the median values of OFER. Table 13 presents the results of the Friedman rank sum test. Figure 21 presents boxplots of OFER for weeks 1 to 5.

*Table 12 OFER: Friedman Rank Sum Test*

Variable	Mean Rank	$\chi^2$	<i>df</i>	<i>p</i>
OFER_Total1	3.13	18.51	4	< .001
OFER_Total2	3.13			
OFER Total3	3.43			
OFER Total4	2.80			
OFER_Total5	2.51			



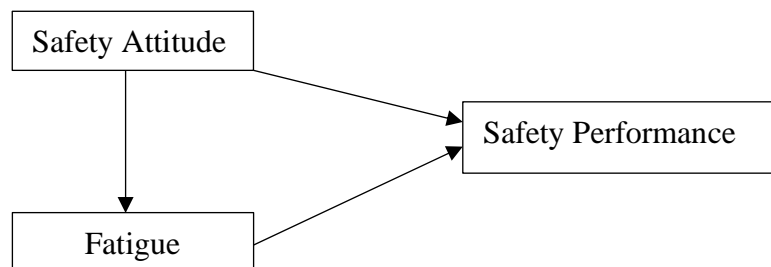
*Figure 22 Boxplots of OFER for weeks 1, 2, 3, 4, and*

## CHAPTER 5: CONCLUSION

Throughout the research, surveys, and direct contact with construction workers and their points of view, it was clear construction safety is a critical side of the construction industry. This industry has the utmost number of fatalities among other industries since workers face different types of hazards, ranging from falls from heights, exposure to harmful chemicals, heavy machinery accidents, low levels of safety attitude to high levels of fatigue. When safety is prioritized in the construction industry, injuries, fatalities, and loss of property can be prevented. Safety performance in the construction site can be measured by some indicators, among these indicators, safety attitude was an essential part of this study. Safety attitude refers to an individual's beliefs and behaviors related to workplace safety, it is an important aspect to create a safe work environment and prevent accidents and injuries. Research has shown that a positive safety attitude can impact workplace safety significantly, for instance, Smith and colleagues (2016) found that employees with an affirmative safety attitude were more likely to comply with safety policies and procedures, engage in safe behaviors, and report safety concerns. Similarly, a study by Zohar and Luria (2005) found that a positive safety attitude was associated with a few accidents and injuries in the workplace. Safety attitude is a leading indicator for construction safety, it can be affected by personal factors, organizational culture, situational and industry-related factors, social factors, and other miscellaneous elements. Fatigue is present among these personal factors; it is also a common issue that affects construction workers. It was noticed that fatigue levels changed in short periods, but these changes did not lead to changes in safety attitude levels, the safety attitude levels did not change in short periods, on the contrary, changes in Safety attitude impacted fatigue levels among construction workers.

This study analyzed the impact of fatigue on the safety performance of construction workers based on onsite surveys which measure fatigue and safety attitude levels. According to each participant's response during eight weeks, each person's fatigue and safety attitude levels were calculated. Eighty workers were interviewed during the research study. The first analysis based on the data of week one showed there was a correlation between the three scales used to measure fatigue (CIS, FAS, OFER). After this, a linear regression between the safety attitude and OFER scale was done with the data of the first five weeks and the results of the linear regression model were significant for all the weeks analyzed.

Subsequently, a repeated measures analysis of variance (ANOVA) was conducted to determine if there are significant differences in safety attitude and fatigue over the five weeks. The results of this analysis showed a constant value for safety attitude and variations in the value for fatigue. In addition, as an alternative, a Friedman rank sum test was conducted, giving the same results as the repeated measures analysis of variance (ANOVA). The outcomes of these examinations showed that fatigue does not affect the safety attitude, however, safety attitude does affect fatigue, at least, for short periods. (Figure 34)



*Figure 23 Relationship between safety attitude, safety performance, and Fatigue*

In conclusion, this study finds that, among all industries, the construction sector is the one with the highest number of fatalities. Also, this study concluded that safety attitude is a leading indicator for construction safety and that fatigue can be described as a common factor that affects the safety of construction workers.

On the other hand, this study found that there is a correlation between the instruments to measure fatigue such as OFER, CIS, and FAS. Moreover, it founds that fatigue levels change in short periods, and for that reason, changes in fatigue levels do not lead to changes in safety attitude levels among construction workers. For that reason, this investigation can affirm that safety attitude levels do not change in short periods but changes in Safety attitude levels impact fatigue levels among construction workers.

### Limitations Of The Study and Recommendation for Future Research

Other studies had measured fatigue against other safety indicators such as safety risk perception or hazard recognition. Nevertheless, some studies have analyzed the impact of fatigue on construction workers. All surveys were conducted in North Carolina and face to face. A more precise picture could have been obtained if the investigation had a bigger sample size taken from different locations in the EE. UU. Also, it is difficult to find construction workers who can provide data for eight weeks due to constant changes in the worksite. Moreover, sometimes workers were not able or willing to stop doing their job for the time of the survey and many times supervisors didn't allow them to participate. Construction workers have an hourly salary and were afraid to lose some of their income when they gave their time to other matters different from their work. Some communities or cultural groups in the construction industry were reluctant to provide any type of personal information, even though it was clarified that the information was anonymous and destined for a study that was not going to affect their job in any way.

Finding job sites with a constant worker count or finding the same person in the same location was difficult, which made commuting to these locations more complex, sometimes workers were not in the agreed job site or at the time previously scheduled.

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## APPENDIX A: SAMPLE QUESTIONNAIRE FOR WEEK 1

(DEMOGRAPHICS, OFER, FAS, CIS, and SAFETY ATTITUDE)



What is your name?

Is this the first time you have taken this survey?

Yes

No

Age

Gender

- Male
- Female
- Non-binary / third gender
- Prefer not to say

Ethnicity

- Caucasian
- African-American
- Latino or Hispanic
- Asian
- Native American
- Two or More
- Other/Unknown
- Prefer not to say

How many years of construction experience do you have?

Current job title

## Education

---

- Some High School
  - High School
  - Bachelor's Degree
  - Master's Degree
  - Ph.D. or Higher
  - Trade School
  - Prefer not to say
- 

## Do you have an OSHA 10/OSHA 30 certification?

---

- Yes, OSHA 10
  - Yes, OSHA 30
  - Yes, both OSHA10/30
  - No
- 

## Have you been injured at work in the past 12 months?

---

- Yes
  - No
- 

## What kind of beverage do you typically drink? (please select all that apply)

---

- Water
- Soda
- Energy drinks
- Coffee
- Tea
- Juice
- Alcoholic beverages
- Others

---

How often do get paid for work?

- Daily
- Weekly
- Bi-weekly
- Semi-monthly
- Monthly
- Other

---

How long do you drive on a typical work day?

---

How long did you drive today?

---

When was the last time you ate food?

---

When was the last time you drank water/had a beverage?

---

What did you drink?

---

How many hours did you sleep last night?



With the below questions, please rate how you felt in the last week.

---

I feel tired

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I have a low output

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Physically I feel exhausted

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I have trouble concentrating

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Physically I feel I am in a bad condition

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I feel very active

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---



---

Mentally, I feel exhausted

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I do quite a lot within a day

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I don't do much during the day

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I get tired very quickly

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I am full of plans

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I am bothered by fatigue

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

---

Thinking requires effort

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I have problems at starting things

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I feel fit

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I feel weak

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I feel like doing all kinds of nice things

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I have problems thinking clearly

---

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I can concentrate well

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I feel rested

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I have enough energy for everyday life

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I feel no desire to do anything

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Physically I feel in a good shape

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

My thoughts easily wander

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Recovering from work fatigue between shifts isn't a problem for me

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I often dread waking up to another day of my work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

After a work shift I have little energy left

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I usually have lots of energy to give to my family or friends

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I usually feel exhausted when I get home from work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I often wonder how long I can keep going at my work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I usually have plenty of energy left for my hobbies and other activities after I finish work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I rarely recover my strength fully between shifts

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I'm often still feeling fatigued from one shift by the time I start the next one

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Even if I'm tired from shift, I'm usually refreshed by the start of the next shift

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I often feel I'm 'at the end of my rope' with my work

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I never have enough time between shifts to recover my energy completely

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I never have enough time between shifts to recover my energy completely

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

My work drains my energy completely every day

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I feel that most of the time I'm just "Living to Work"

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Too much is expected of me in my work

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Answer the following questions in relation to Safety Attitude Measurement

---

Do you feel that safety training courses are necessary?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Would you feel safer working with someone who has completed an accredited safety course?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Would you feel less safe working with someone who hasn't completed an accredited safety course?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Do you agree that completing a safety training course will make you competent?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Do you believe safety training programs are complex and hard to understand?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Would you pay for a safety training course if it meant improving your personal safety?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you attend a free safety training course if it meant improving your personal safety?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you know what to do if a colleague of yours was working unsafely?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Do you personally feel that you need to attend a safety course each time you work on a new site?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you saw someone acting unsafely would you notify the safety officer?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you bend the rules to meet strict construction deadlines?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



If you knew something was unsafe but it meant getting the job done, would you still do it?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

If you sustained a minor injury working, do you believe it is necessary to report?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



After a work shift I have little energy left

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I never have enough time between shifts to recover my energy completely

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Even if I'm tired from shift, I'm usually refreshed by the start of the next shift

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I often dread waking up to another day of my work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I usually feel exhausted when I get home from work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I'm often still feeling fatigued from one shift by the time I start the next one

Strongly disagree	Disagree	Slightly disagree	Neither agree nor disagree	Slightly agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Too much is expected of me in my work

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I usually have lots of energy to give to my family or friends

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

I feel that most of the time I'm just "Living to Work"

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Recovering from work fatigue between shifts isn't a problem for me

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Answer the following questions in relation to Safety Attitude Measurement

---

Do you feel that safety training courses are necessary?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Would you feel safer working with someone who has completed an accredited safety course?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Would you feel less safe working with someone who hasn't completed an accredited safety course?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Do you agree that completing a safety training course will make you competent?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Do you believe safety training programs are complex and hard to understand?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

Would you pay for a safety training course if it meant improving your personal safety?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you attend a free safety training course if it meant improving your personal safety?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you know what to do if a colleague of yours was working unsafely?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

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Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

If you saw someone acting unsafely would you notify the safety officer?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you bend the rules to meet strict construction deadlines?

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

If you knew something was unsafe but it meant getting the job done, would you still do it?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

---

If you sustained a minor injury working, do you believe it is necessary to report?

---

Strongly Disagree	Disagree	Slightly Disagree	Neither Agree or Disagree	Slightly Agree	Agree	Strongly Agree
<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

# APPENDIX C: UMCIRB APPROVAL



**EAST CAROLINA UNIVERSITY**  
**University & Medical Center Institutional Review Board**  
4N-64 Brody Medical Sciences Building · Mail Stop 682  
600 Moyer Boulevard · Greenville, NC 27834  
Office 252-744-2914 · Fax 252-744-2284 ·  
[rede.ecu.edu/umcibr/](http://rede.ecu.edu/umcibr/)

## Notification of Amendment Approval

From: Social/Behavioral IRB  
To: [Mostafa Namian](#)  
CC: [Mostafa Namian](#)  
Date: 2/13/2023  
Re: [Ame2 UMCIRB 22-001818](#)  
[UMCIRB 22-001818](#)  
Fatigue among construction workers

Your Amendment has been reviewed and approved using expedited review on 2/13/2023. It was the determination of the UMCIRB Chairperson (or designee) that this revision does not impact the overall risk/benefit ratio of the study and is appropriate for the population and procedures proposed.

Please note that any further changes to this approved research may not be initiated without UMCIRB review except when necessary to eliminate an apparent immediate hazard to the participant. All unanticipated problems involving risks to participants and others must be promptly reported to the UMCIRB. The investigator must adhere to all reporting requirements for this study.

If applicable, approved consent documents with the IRB approval date stamped on the document should be used to consent participants (consent documents with the IRB approval date stamp are found under the Documents tab in the study workspace).

The approval includes the following items:

Document	Description
Benign Behavioral Interventions consent template_1.21.19 - Spanish.docx(0.01)	Consent Forms
Spanish survey - V1.pdf(0.01)	Surveys and Questionnaires

For research studies where a waiver or alteration of HIPAA Authorization has been approved, the IRB states that each of the waiver criteria in 45 CFR 164.512(i)(1)(i)(A) and (2)(i) through (v) have been met. Additionally, the elements of PHI to be collected as described in items 1 and 2 of the Application for Waiver of Authorization have been determined to be the minimal necessary for the specified research.

The Chairperson (or designee) does not have a potential for conflict of interest on this study.