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**Volume 1: Hazards in Common Workplaces**

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## INTRODUCTION

The Occupational Safety and Hazard Control course is offered every Fall Semester as a technical elective for undergraduates in Industrial and Systems Engineering. It is also a course that is taken by graduate students with an interest in occupational health and safety.

As the teaching lead for this course, I used a pedagogical method that focused on engaging students as citizen scholars. This approach required students to apply what they were learning to address problems in real-world occupations within the local community in and around Virginia Tech. Students were required to identify a problem, explore the topic in the scholarly literature, develop research questions, propose a research project, and acquire approval from the Institutional Review Board of Virginia Tech. Students were allowed to select from a list of suggested topics or propose topics of their own. Students with similar interests were encouraged to form teams to expand the problems of interest in to one topic. Once these requirements were met, students conducted research and submitted an APA-formatted research paper. These papers are published in this volume.

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Tonya L. Smith-Jackson, Ph.D., Associate Professor

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## **SAFETY AND RISK PERCEPTIONS OF EXPERIENCED VERSUS INEXPERIENCED VOLUNTEER CONSTRUCTION WORKERS**

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### **ABSTRACT**

The not-for-profit construction industry relies primarily on volunteer labor in its mission to build affordable housing for low-income families. In an environment of skilled laborers and volunteers, there is a gap in experience that can lead to different perceptions of risk and construction safety and can be potentially hazardous. The purpose of this study was to assess the perception of risk for different construction tasks and to determine perceptions of safety procedures for both experienced and inexperienced volunteers. Ten inexperienced and ten experienced volunteers were surveyed to determine differences in risk perceptions and safety training. Results were used to identify areas for improvement and provide training recommendations for volunteer construction workers.

### **INTRODUCTION**

According to the Bureau of Labor Statistics of the 5,703 fatal work injuries in the United States in 2006 the construction industry accounted for 1,226 of these fatal injuries (BLS, 2007). This represents the most of any single industry sector. In the construction industry there are non-profit companies, such as Habitat for Humanity (HFH), that build affordable residential housing for low-income families. A majority of the labor is completed by volunteers with varying degrees of construction experience. In 2006 over 32,000 volunteers registered through HFH to help build and repair houses (HFH, 2006). Providing adequate safety training and understanding of OSHA regulations to volunteers with varying levels of experience can be difficult. It is further complicated by the fact that some workers volunteer repeatedly while others may only volunteer one time for a short period of time. With experienced and inexperienced volunteers working side by side in such a dangerous industry there is a high level of risk

to all volunteers. This is compounded by the fact that many of the supervisors on the sites are skilled laborers who have to divide their attention between monitoring volunteers and completing constructions tasks.

### **LITERATURE REVIEW**

The Department of Labor's study of volunteer worker fatal injuries attribute three percent of all fatal volunteer injuries between 1993 and 2002 to construction laborers (BL, 2005). For such a specific field this represents a major problem in regards to safety and hazard control. According to one study there is no set agreement on construction safety roles on a job site in the private industry (Toole, 2002). In the volunteer construction environment, the miscommunication of safety responsibility can have more hazardous effects on the unskilled workers. They may be unskilled in the field and need set roles and responsibilities of supervision to perform tasks in a safe manner. There is a need for organizational safety training and supervision. On the individual level, Lindell noted that workers need skills and knowledge and the

right attitude on the job site (Lindell, 1994). In an environment with varying skills, knowledge, and attitudes it is important to continually assess areas where there is a gap in the understanding of risks and the proper methods for safety. This study sought to further research on volunteer safety specifically in the construction industry. By gauging the gap between experienced and inexperienced volunteers and their perception of risks and safety, the hazard control priority framework can be used to ensure safety is integrated with construction through various means. Different measures can be designed to address the different levels of experience of the volunteers.

### **PURPOSE OF THE STUDY**

The purpose of this study was to determine the perceived degrees of risk of various construction tasks to experienced and inexperienced volunteers. The study also determined the perceived understanding of construction safety practices of experienced and inexperienced volunteers. By comparing and contrasting the different participants' understanding of potential risks and proper safety practices, areas needing more training and training recommendations were developed.

### **METHOD**

#### **Research Design**

This study used a subjective method to identify participants' perceptions. Experienced and inexperienced volunteers were divided based on the number of hours spent on a construction site. All participants with less than forty hours of construction experience were considered inexperienced workers. Volunteers with over forty hours of construction experience were considered experienced workers.

#### **Participants**

The study involved 20 participants from Virginia Tech over the age of eighteen.

The participants were all undergraduate or graduate students who have volunteered with Habitat for Humanity or other volunteer construction projects for at least one day. They ranged in age from 20 to 30 years of age. Of these 20 participants, ten had at least a week, or forty hours, of experience on a construction job site either as a volunteer or in a paid position. Ten had less than a week, or forty hours, experience on a construction job site. Participants were selected from service organizations at Virginia Tech, such as the Habitat for Humanity chapter, German Club, and Circle K. Of these 20 participants 19 were male and 1 was female. Five of the participants were juniors, eleven were seniors, and four were graduate students.

#### **Questionnaires**

Questionnaires were developed and used to gauge the participants' perceptions of risk and safety practices. The same questionnaire was administered to both groups of participants.

The first part of the questionnaire provided demographic information about the participants including age, gender, academic year, and field of study in college. The second part of the questionnaire asked questions about the participants' relevant construction experience both as a volunteer and as an employee. This section established in what capacity the participant worked in construction and also the number of hours completed in both fields. The next section of the questionnaire used quantitative metrics and qualitative indicators to determine participants' risk perception. Likert questions were focused on perceived levels of risk of different tools and hazards on a construction job site. The participants were also asked to name the three most dangerous tools and three most dangerous situations during their construction experience. The final section included Likert and open-ended questions regarding the participants' understanding of safety practices and equipment during their construction experience.

**Procedure**

After determining interest in completing a questionnaire for the study through a flier, participants were contacted to arrange a time to administer the questionnaire. Informed consent was acquired before completing a survey. The researcher ensured that the participants understood the form before completing it. On the informed consent form, participants were required to certify that they were at least 18 years of age and had completed at least one hour of construction on a work site. After completing the informed consent, the researcher distributed the questionnaire and asked that the participant complete the questionnaire, including all open-ended questions. All questionnaires were completed in less than 30 minutes.

**RESULTS**

**Risk Perception**

Based on the participants’ responses to the questionnaires, the means and standard deviations for the perceived levels of risk were compiled for both experienced and inexperienced volunteers. These data are presented in Table 1.

**Table 1.** Risk Perception Means & Standard Deviations.

Risk Source	Experienced		Inexperienced	
	Mean	Standard Deviation	Mean	Standard Deviation
Overall	3	0.94	4.1	1.10
Hand Tools	2.9	1.37	3.6	1.26
Power Tools	4.1	1.20	4.8	0.92
Ladders	3.7	1.16	3.8	1.40
Slips/Falls	3.5	1.90	3	1.05
Physical	3.1	1.37	3.4	0.97
Auditory	3.3	1.70	3	1.41
Other Volunteers	3.1	1.37	3.9	1.73

Inexperienced volunteers had a higher mean level of risk perception overall. The inexperienced volunteers also felt that there were higher levels of risk associated with all tasks and tools in construction except slips and falls and auditory risks. Both groups found

power tools to be the highest source of risk in construction. Based on the open-ended questions, both inexperienced and experienced participants identified various types of saws, such as chop saws, table saws, saws-alls, and jigsaws, as the most dangerous tools used on the construction sites. Nail guns and ladders were also identified as dangerous tools used on worksites. Experienced volunteers noted heavy machinery and professional construction tools as dangerous items. The most common dangerous situations were a result of heights, either on a roof or on a ladder, and inexperience of volunteers using power tools.

**Safety Procedures**

The participants’ responses regarding safety procedures were compiled to calculate means and standard deviations. Table 2 presents the results of the safety questions for experienced and inexperienced volunteers.

**Table 2.** Safety Perceptions Means & Standard Deviations.

Safety	Experienced		Inexperienced	
	Mean	Standard Deviation	Mean	Standard Deviation
Overall	4.4	1.17	4.5	1.18
Instruction	3.4	1.58	4	1.15
Supervision	3.5	1.18	3.7	1.49
Safety Equipment	4.3	1.25	4	0.67

Overall, inexperienced volunteers felt safer on construction sites than experienced volunteers. The one area where inexperienced volunteers felt less safe than experienced volunteers was safety equipment. While most volunteers were issued hard hats and safety goggles, many wished that they had been issued gloves, steel-toed boots, and ear plugs on the construction site. Areas for more safety training include heights, such as ladders and roofs, and using power tools. Participants also noted in regards to safety that there should be better supervision on volunteer construction sites.

## DISCUSSION

Based on the quantitative and qualitative data compiled from the participants in this study, certain areas where a gap between experienced and inexperienced volunteers' perception of risk and safety were identified. Inexperienced volunteers differed from experienced volunteers in the risk associated with hand tools. This can be attributed to a lack of comfort in using hand tools. The discomfort could be addressed with training and practice. Both groups rated power tools as the highest level of risk on a construction site. This is one of the areas that should be addressed to a greater extent for volunteer construction safety orientations. This discomfort was also evident by the number of power tools listed as most dangerous tools used by participants. Neither group of participants rated auditory risks from tools such as saws, drills, and nail guns, as high risks. However, earplugs were listed as protective equipment that was issued. The lack of awareness of hazards associated noise made by power tools should be addressed by providing the equipment and educating volunteers on the dangers of the noise produced by power tools. Although the participants rated slips and falls and ladders with a low level of risk, there were a large number of dangerous situations involving heights that participants listed. This is another area for hazard control. The challenge of addressing hazards associated with working at heights is not only related to providing proper safety training, but also should assure volunteers are aware of the specific hazards and associated risks.

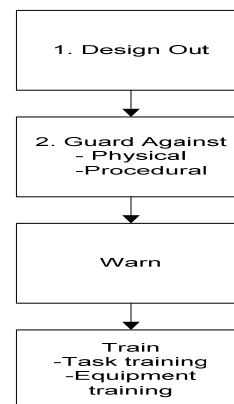
In general, the inexperienced volunteers felt safer on construction sites than experienced volunteers. The fact that inexperienced volunteers feel safer than experienced workers shows that more must be done to make new volunteers aware of the dangers associated with the construction industry. Both groups felt that there was a need for more safety equipment on volunteer construction job sites. This issue can be a

financial one when it comes to not-for-profit construction companies that have limited budgets and often work through grant money. Instruction and supervision received low rankings, which indicate that both of these areas need improvement in volunteer construction. On the open-ended questions, some participants cited lack of and poor supervision as areas needing improvement. Improving safety training will not be very effective without supervisors present to reinforce what was learned during training with the volunteers.

## CONCLUSIONS

The findings of this study provide a basis for better integrating safety and hazard control into volunteer construction environments. In order to provide multiple safety measures in volunteer construction, the priority framework was utilized in making recommendations. The priority framework uses four different methods to address hazards in the workplace. Hazards should be addressed starting at step one and working down to step four when dealing with a hazard in the workplace. Figure 1 shows the Hazard Control/Priority framework for designing a system for safety.

**Figure 1.** Priority Framework.



In approaching volunteer construction and with the exception of machinery that currently replace tasks, designing out is not

really an option because all tasks must be completed to finish a home. Although not an engineering control (designing out), utilizing professionals in completing some of the construction tasks. This form of work process control is already done with electrical and plumbing work on the homes. Volunteer construction groups might consider requiring professionals to complete tasks that require skilled labor or the use of dangerous tools or machinery. Two methods of guarding against should be implemented in volunteer construction. As noted by the responses of the participants, more physical guards should be provided to the workers. Physical guards include protective equipment, such as gloves and ear plugs that participants wish they had received. It is important to provide not only the required protective equipment, but also any necessary equipment to volunteers since they are not necessarily aware of all the consequences of accidents or tasks on construction sites. Procedural guards should be used to address the gap in comfort and skill in using power tools. There should be a process for qualifying on certain power tools that can add risk to both the user and other volunteers. These tools could include saws and nail guns and any other hazardous power tool that requires both safety and operational training. Procedural guards should also be used on volunteers who come to a job site with little experience and who plan to work for a short amount of time. These workers should only be placed on jobs with little risk and that require the use of simple tools on which they can easily and quickly trained. The final two steps of the priority framework should already be utilized, but should be enhanced to address the concerns of volunteers. Not-for-profit construction companies should develop effective ways to warn and train volunteers. Training methods should be developed for both short-term and long-term volunteers to protect them from internal and external hazards. Training should communicate not only procedures, but also potential risks of various tools and tasks.

## ACKNOWLEDGEMENTS

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## Appendix A

Please complete the questionnaire to the best of your ability. You may not ask questions during the questionnaire. Check the boxes which apply to you. Circle the option which best describes your thoughts. For the open-ended questions please give as much information as possible.

## DEMOGRAPHIC INFORMATION

Gender:  Male  Female

Age: \_\_\_\_\_ years old

Academic Year:  Freshman       Sophomore  
 Junior    Senior    Graduate Student

Field of Study:  
\_\_\_\_\_

**RELEVANT EXPERIENCE**

Have you ever worked in the construction industry in a paid position?  
 Yes                       No

If yes, for how many hours approximately?  
\_\_\_\_\_

Have you ever worked in construction as a volunteer for a non-profit (ex/ Habitat for Humanity)?  
 Yes                       No

If yes, for how many hours approximately?  
\_\_\_\_\_

**RISK PERCEPTION (1= low, 7 = high)**

- 1. I would rate the overall level of risk working on a volunteer construction site as:
- 2. I would rate the level of risk from using hand tools as:
- 3. I would rate the level of risk from using power tools as:
- 4. I would rate the level of risk from using ladders as:
- 5. I would rate the level of risk from slips and falls as:
- 6. I would rate the level of physical risk as:
- 7. I would rate the level of auditory risk as:

8. I would rate the level of risk from other volunteers as:

9. Please list the top 3 most dangerous tools you used on a construction site.

10. Please list the top 3 more dangerous situations you encountered on a construction site.

**SAFETY PROCEDURES**

11. I would rate the overall level of safety on the construction site as:

12. I would rate the safety instruction I received at the construction site as:

13. I would rate the safety supervision on the construction site as:

14. I would rate the protective equipment provided to me as:

15. Please list the safety equipment you were issued at the construction site.

16. Please list any safety equipment you were not issued but you think would be appropriate.

17. Please list areas where you think there should be more training on safety.

18. Please add any additional comments on safety training for volunteers.

## **SAFETY PERCEPTION DIFFERENCES BETWEEN LATINOS AND NON-LATINOS**

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### **ABSTRACT**

The control of hazards and implementation of safety regulations in a construction site are of extreme importance. However, maintaining worker safety not only depends on management, but also on the workers themselves. In this research, we present the results of a study that aims to identify differences in how workers from different cultures (Latinos and non-Latinos) perceive the importance of a safe workplace.

### **INTRODUCTION**

In every workplace, management and employees should work together towards controlling and eliminating hazards. The construction industry is especially sensitive to this matter, because of the hazards involved, and the rates of injuries and fatalities that occur. "Despite the programs implemented by government authorities, and measures introduced by companies themselves, the number of construction accidents still remains alarmingly high" (Ai Lin Teo et al., 2005)

In the construction industry, it is important that management ensures that the construction site complies with relevant safety regulations. In the United States, the Occupational Safety and Health Administration (OSHA) states regulations to ensure employee safety. Under the OSHAct of 1970, employers are responsible for providing safe and healthful workplaces for their employees ([www.osha.gov](http://www.osha.gov)). A specific standard from the OSHA regulations regarding safety equipment is 29 CFR 1910.132, which states that when engineering controls do not provide sufficient protection, employees must wear safety equipment that should be provided by the employee. Consequently, on Nov 14, 2007 OSHA announced that all protective equipment must be provided and paid by the employee.

It is also important to worker safety that management provides training on such matters as safe postures, safe use of tools and equipment, and safe procedures. Workers should then comply with the safety system provided by their management. They should

wear protective equipment, and should use the appropriate tools and machinery.

However, the communication between management and workers and between co-workers can be challenged by cultural barriers. An increase in migrant workers has brought this problem to the construction industry in the US and other countries. Studies have shown that migrant workers experience more injuries. Among the primary causes is limited comprehension of safety instructions. Another factor could also be a relatively lower concern by migrant workers about safety measures because of they have been socialized in other cultures that may not impose regulatory or voluntary controls to the extent found in the U.S. culture. As international students, coming from Latin American countries, the driver of our study was our own lived experience and observations in our home countries concerning safety and security measures at construction sites. Similar to other countries when compared to the U.S., safety within some Latin American countries is less regulated and organizational safety values may also be relatively lower. We designed a study to explore this possible difference.

### **LITERATURE REVIEW**

A literature review was conducted on relevant studies. Previous studies have shown that lack of concern among workers increases the probability of getting injured; whereas having a safe work behavior decreases this probability. Some studies found that language and culture differences create barriers in communication in the workplace, and may lead to

misunderstanding instructions, which may therefore lead to injuries.

Hispanics workers tend to “have higher fatal and non-fatal occupational injuries than any other ethnic group in the United States (Brunette., 2004, p. 245).” Common reasons to explain the disparity in accidents between Hispanic and non-Hispanic construction workers are differences in language and culture. It is important that Hispanics understand the language in which they receive safety training, and there are studies that indicate a majority of Hispanic workers do not understand a substantial amount of the training they receive (Goodrum et al., 2005).

Trajkovski and Loosemore (2006) conducted a student to explore the influence of cultural and linguistic barriers on safety at construction sites. The study showed that half of the participants admitted to having misunderstood instructions, and more than half admitted having made mistakes as a result of low comprehension (Trajkovski et al., 2006). Other common factors associated with accident disparities identified by other researchers include lack of training, lack of supervision, lack of means to carry out a task safely, carelessness and apathy (Sawacha et al., 1999).

However, it has also been found by some that the majority of accidents are not caused by careless workers, but by lack of control and supervision by management, which tends to be part of a positive safety climate. One study found a positive correlation between having a positive safety climate in the workplace and safe work behavior. A positive safety climate can be achieved by management by showing commitment to workers and promoting safe practices in the workplace (Mohamed, 2002).

**PURPOSE OF THE STUDY**

There were two main purposes or research questions for this study. One was to find out how much importance construction workers placed on safety measures. The second was to determine whether there were any differences in how workers from different cultures perceived safety issues in the workplace.

The hypothesis of the study was that there would be differences between the safety

perception of Latino construction workers and non-Latino construction workers.

**METHOD**

**Research Design**

Construction workers were interviewed and divided into two cultural groups, Latinos and non-Latinos. This study was conducted in parallel with another research project: *Informal Education and Training for Small Construction Firms*. Some of the authors were working on both projects at the same time. Therefore, questions were integrated into one questionnaire to the benefit and efficiency of both projects.

**Participants**

The participants of the study were construction workers. Thirty workers were recruited. Fifteen were Non-Latinos, and the other fifteen were Hispanic/Latinos. Figure 1 presents a pie chart with the native countries of the participants. Figure 2 shows the distribution of participants’ ethnic groups. Since it is more common to find males rather than females working in construction, we had only one female participant. The average age of participants was 32 years (*SD* = 11.91). The average number of years laboring in the construction industry was 8.99 years (*SD*=8.74). They had all worked all or most of these years in the United States, but some Hispanic/Latinos had previously worked in their native countries as well.

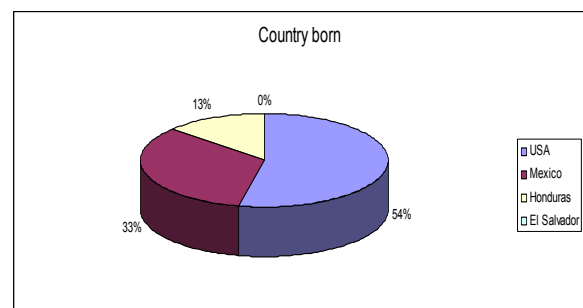


Figure 1 – Native countries of participants.

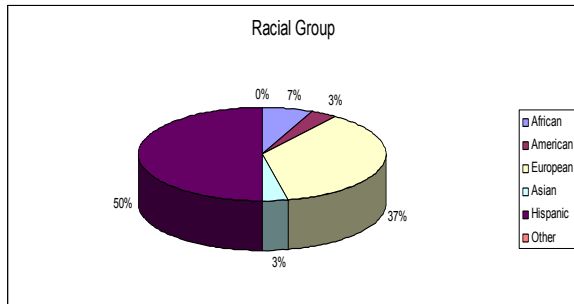


Figure 2 – Racial/Ethnic group of participants.

**Instruments/Questionnaires/Materials/Tasks**

The questionnaire included demographic questions and questions related to safety and security in the workplace. It was designed to get both qualitative and quantitative data. Some examples are presented below, but the complete questionnaire is presented in Appendix A.

- Demographic Questions:
  - Age?
  - Racial/Ethnic group?
- Qualitative Questions:
  - In what countries, other than the US have you worked as a construction worker?
  - What are the differences in safety practices in \_\_\_\_\_ (country), compared to safety practices in the US?
- Quantitative Questions:
  - Scaled 1 to 5
    - In your opinion, how important is it to you to wear protective equipment while you work (for example, hard hats, boots, gloves, etc.)?
  - Yes/No answer
    - Have you ever refused to do a construction task because you did not know how to do it safely?

**Procedure**

Participants were asked to sign a consent form stating that they agreed to complete the survey. They received \$10 as compensation for participating. They were also asked to give permission to be audio taped. If permission was given, researchers asked the questions in the questionnaire and recorded participants' responses. Participants who did not wish to be audio taped completed the questionnaire on their own.

After all 30 surveys were completed (15 to Latin and 15 to non Latin workers), data were analyzed. The data gathered in this study were evaluated using descriptive and inferential statistics.

**RESULTS**

Minitab was used to conduct statistical analysis. Mean values and standard deviations were calculated and t-tests were conducted to explore differences between the two groups. A summary of this information is presented in Table 1. A graphical summary of this information was also developed. A confidence level of 95% was established; alpha of .05.

**Table 1 - Mean and Standard deviation of main variables**

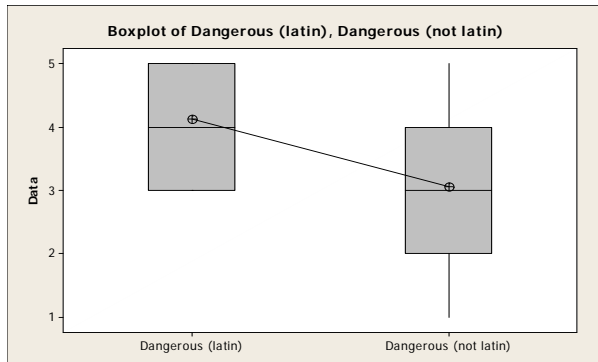
Variable	Mean	StDev
Dangerous (Latino)	4.13	0.92
Dangerous (non-Latino)	3.07	1.03
Importance Protective Equipment (Latino)	4.60	0.83
Importance Protective Equipment (nonLatino)	4.87	0.35
Frequency of equipment usage (Latino)	3.73	0.59
Frequency of equipment usage (nonLatino)	3.80	0.41
Imp. Practice Safety (Latino)	4.80	0.41
Imp. Practice Safety (not Latino)	4.80	0.41

The only statistical difference between Hispanic/Latinos and NonLatinos was in how dangerous they perceived their job to be [ $t(27) = 2.99, p = 0.01$ ]. The box plot in Figure 3 represents this difference. Other t-tests were not found to be statistically significant. A graphical illustration is presented in Appendix B.

Correlation analyses were performed in order to determine if participants' perception of the amount of danger in their job varied in relation to age, work experience, education level, and time living in the United States (for Latinos only).

Previous investigations have found that fatal accidents in construction industry among Hispanic people are associated with age. Specifically, it has been shown that younger people are more likely to suffer this (Fabrega et al., 2001). Another correlation analysis was

conducted to determine if the importance participants gave to wearing protective equipment was related to the frequency with which they used the equipment.



**Figure 3 – Box Plot: T-Test for Dangerous perception.**

The only statistically correlated variables were the importance workers gave to wearing protective equipment and the frequency with which they used them ( $r = 0.65$ ,  $p = 0.00$ ). However, when performing this test separately for each group, there was no significant correlation within the Non-Latino group ( $r = 0.294$ ,  $p = 0.29$ ), but in the Latino group, a significant correlation existed ( $r = 0.78$ ,  $p = .0001$ ).

Danger perception did not have any correlation with the variables tested. Therefore, neither age, work experience, education level, nor time living in the United States, affected how workers' perceptions of the dangers of their jobs. Complete values from correlation tests can be found in Appendix B.

One interesting fact was that from the eleven participants that had working experience outside the United States, 82% said that working in the United States is safer than working in Latin American countries. The remaining 18% said that working in the United States compared to Latin American countries is only slightly safer.

It was also found that all participants believed that protective equipment reduced the probability of being injured if they were involved in an accident. However, just 80% of participants stated that they used protective equipment all the time, 17% said they used it sometimes, and 3% said they used it rarely. When asked to rate how important it is for them to practice safety on the workplace, 80% of

participants rated it as extremely important and the remaining 20% rated it as very important.

## DISCUSSION AND CONCLUSIONS

Although the questionnaires were conducted off-site, the majority of participants initially hesitated to complete the questionnaire. After watching other co-workers participate, they gained more confidence. This initial hesitation may have been associated with a fear of reprimand by supervisors. Not surprisingly, non-Latino participants were more accessible and were less likely to hesitate to complete the questionnaire. Latinos/Hispanic participants were more afraid and didn't express much trust in the study. However, performing the interviews and questionnaires in their native language (Spanish) helped to build rapport and trust.

As expected, there was a slight difference between Latin and Non-Latino construction workers. Latinos perceived their job as more dangerous than Non-Latinos. This result is consistent with differences found in a previous study by Finucane et al. (2000), which were termed the "white male effect." Latino workers' risk perceptions were higher compared to Non-Latino workers, most of which consisted of white males. This relatively lower risk perception among white males is known as the white male effect.

Our data revealed no difference in the perception of importance of using protective equipment nor in the perception of how important it was to practice safety in the workplace. That is, risk perceptions varied between the two groups, but the importance they gave to safety practices and safety procedures was similar. The frequency with which they used protective equipment did not vary either between the two groups of participants.

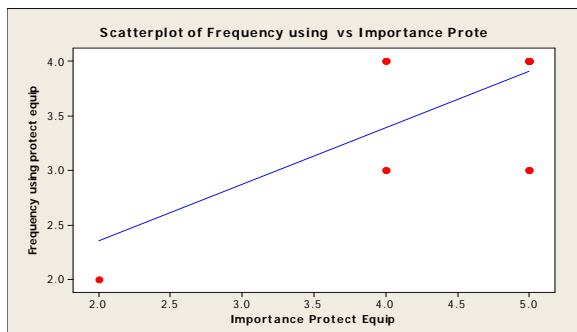
Even though there was no statistically significant difference between Latinos and Non-Latinos in the importance of using protective equipment, and the frequency of using it, these two variables were correlated. How frequently workers used protective equipment was associated with the level of importance they gave to this safety measure. This association is shown in Figure 4.

Perception of importance of safety practices are usually related to training processes that workers receive. Our data showed that the importance that workers give to

the practice of safety is related to the importance they give to safety training ( $r = .40, p = .03$ ).

Results from our study did not show any statistical difference between Latinos and Non-Latinos regarding the importance they gave to receiving safety training. However, a previous study by O'Connor et al. (2005) found that workers who were less familiar with the English language usually received less safety training.

The fact that the majority of Hispanic participants who worked outside the United States reported that working in the United States is safer than in their home countries is an important result. This opinion may be influenced by the difference in level of safety practices, existence and enforcement of safety regulations, and resources and work conditions within each country. The problematic conditions include an unsafe physical environment, no training, and a lack of personal protective equipment (Brunette, 2005).



**Figure 4 – Correlation between Importance of Protective equipment and frequency of using protective equipment.**

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## Acknowledgments

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## Appendix A

### FORMAT HAS BEEN MODIFIED

Participant # \_\_\_\_\_

**Worker Demographic Sheet & QUESTIONNAIRE  
(NO NAMES PLEASE)**

**How long (in years) have you worked in construction?** \_\_\_\_\_

**Age:** \_\_\_\_\_

**Gender:** \_\_\_\_\_ Male  
 \_\_\_\_\_ Female

**Racial/ Ethnic Group (circle one):**

- African-American
- American Indian/Native American
- European-American/Caucasian
- Asian/Pacific Islander
- Hispanic/Latino
- Other

**Education (circle one)**

- Less than 12 years  
 Vocational/Trade school degree or certificate
- 12 years (graduated)  
 College degree (B.S., B.A.)
- Some College or Trade School  
 Graduate (Advanced Degree, M.S.)

**In what country were you born?**

**In what country or countries have you worked as a construction worker?**

**If yes to question #9, what are the differences in safety practices in \_\_\_\_\_ country, compared to safety practices in the US?**

**How long (in years) have you lived in the USA?**

**Safety Climate Questionnaire (Oral administration or given to participant based on preference)**

Instructions: Please answer each question to the best of your ability by placing an X or check on the box containing the number that best represents the strength of your opinion.

1. On a scale from 1 to 5, how dangerous is your construction job (not at all = 1, extremely = 5)?
2. In your opinion, how important is it to you to wear protective equipment while you work (for example, hard hats, boots, gloves, etc.) (not at all = 1, extremely = 5)?
3. Besides a hard hat, how frequently do you wear protective equipment at work (1=never, 2=rarely, 3=sometimes, 4=always)?
4. How important is it to you to practice safety on the job (not at all = 1, extremely = 5)?
5. Do you believe protective equipment protects you by reducing the chances that you will be hurt or injured if you have an accident? Yes or No
6. If you worked in construction in this country, how do safety practices in the USA compare to the country you worked in previously? If you have only worked in the USA, please do not answer this question (1=much less safe, 2=slightly less safe, 3=about the same, 4=slightly more safe, 5=much more safe).

Thank you for completing this questionnaire!

Table 2 – Correlation results for main variables

Variables	Pearson-r	P-value
Dangerous, Importance Protect Equip	0.039	0.837
Dangerous (latin), Importance Protec equip (latin)	0.358	0.190
Dangerous (not latin), Import Protect equip (not lat)	-0.170	0.544
Dangerous, Importance Practice Safety	0.200	0.289
Dangerous (latin), Imp. Practice Safety (lat)	0.452	0.091
Dangerous (not latin), Imp. Practice Safety (not lat)	0.033	0.906
Dangerous (latin), Time living in the US (lat)	-0.228	0.413
Dangerous, Education	-0.266	0.155
Dangerous (latin), Education (lat)	0.028	0.921
Dangerous (not latin), Education (not lat)	-0.259	0.350
Dangerous, Age	-0.087	0.646
Importance Protect Equip, Frequency using protect equip	0.656	0.000
Importance Protec equip (latin), Freq using protect equip (lat)	0.785	0.001
Import Protect equip (not lat), Freq using prot equip (not lat)	0.294	0.287
Time worked in const, Dangerous	-0.129	0.496
Time worked in constr (latin), Dangerous (latin)	0.274	0.322
Dangerous (not latin), Time work in constr (not latin)	0.061	0.829

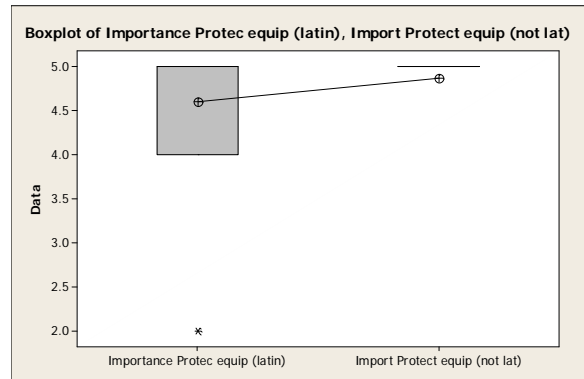


Figure 5 – Box Plot: T-Test for Importance of Protective Equipment mean comparison.

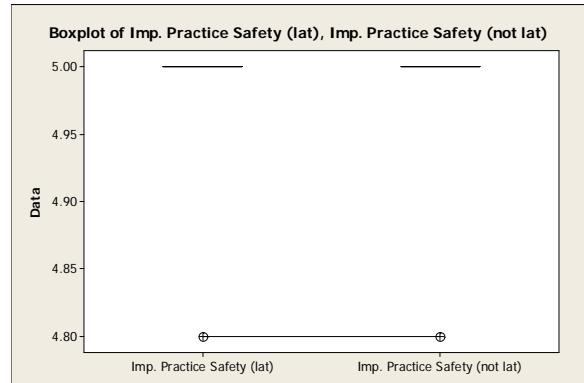


Figure 6 – Box Plot: T-Test for Importance of Practice safety mean comparison

## MAIL DELIVERY SERVICE: A SAFETY ANALYSIS

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### ABSTRACT

This study was conducted to determine possible safety hazards that may occur during the process of receiving, sorting, and delivering mail parcels of various sizes. Data were collected through observation as well as worker questionnaires to determine safety issues through multiple venues. Principles of Occupational Safety were applied in determining recommendations to increase the safety of the sorting room operation. This study showed that several hazards existed in the observed mail delivery service and most could be eliminated with little effort or cost.

### INTRODUCTION AND PROBLEM

The industry of mail delivery has risks involved in the movement of mail and packages. Employees have to lift, bend, push, pull, carry, drive and walk during the receiving, sorting, and delivering phases of the process. Risks may include: back injuries due to improper lifting, slips and falls, chronic pain due to the static work, driving related injuries, and stress.

A study in the area of lifting has shown that managers of small to medium industries usually allow employees to set their own safe lifting limits. This is due to the way managers perceive environmental safety. It is evident that they are more likely to allow heavier loads to be lifted because of perceived "safe" work conditions. However, it was observed that these employee limits were quite close to those set by the National Institute for Occupational Safety and Health (NIOSH)<sup>2</sup>.

To see how these safety issues are handled in mail delivery, the team chose

to observe a small mail delivery service in the New River Valley region. Thus, the goal of the team was to observe the overall organization of the delivery service and determine hazards present. In addition, mail processing and handling techniques were observed in the incoming mail, sorting, and delivery phases. Using observational data, a safety risk analysis was performed and recommendations made to improve safety.

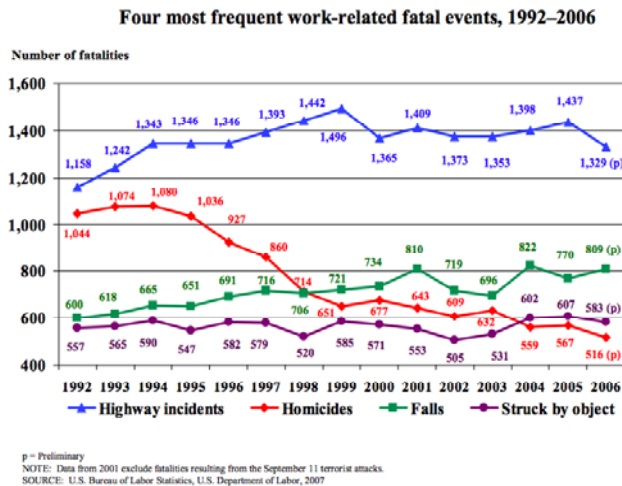
### LITERATURE REVIEW

The US Bureau of Labor Statistics reported the four highest occupational related fatalities as seen in *Figure 1*<sup>12</sup>. These events are all possibilities in a parcel delivery service that deals with delivery vans, heavy packages, multilevel terrain, stress, and unknown circumstances.

Due to the high number of highway incidents, delivery driver safety is a major concern. The Federal Motor Carrier Safety Administration (FMCSA) reported that delivery drivers of

“independent and local fleets” used safety belts 44% of the time, which is significantly lower than the passenger car driver rate of 79%<sup>1</sup>. Also noted is that passengers are even less likely to wear a seatbelt in both circumstances<sup>1</sup>. In 2002, the FMCSA reported that more than 50% of the 588 commercial motor vehicle (CMV) driver fatalities occurred

which deliverers face may increase the possibility of a fall. The necessary movements for proper locomotion may also be affected by the tasks required for the job. Researchers at Virginia Tech reported repetitive lifting can fatigue the appropriate muscles needed to perform a task and lead to overcompensation in reflex amplitude<sup>5</sup>. Fatigue caused by lifting is also suggested to reduce spinal stability, therefore contributing to the risk of low-back injury<sup>4</sup>. A study at The Ohio State University’s Biomedical Engineering Center showed repetitive lifting can lead to a decrease in lifting power and postural stability<sup>7</sup>. Another study has shown that standing or walking for long periods of time can lead to lower extremity discomfort, orthopedic deformities, fatigue, and low back pain for workers<sup>7</sup>. Employees required to stand in limited or cramped workspaces have been found to have high rates of lower extremity pain and discomfort<sup>7</sup>. This evidence suggests that the employees in this study could experience muscle fatigue, pain, muscular overcompensation, and other factors that may lead to an increased risk of falling.



**Figure 1**

when not wearing seat belts and 80% that were ejected from the vehicle were also not wearing seatbelts<sup>1</sup>. Charbotel, a French researcher studied hospital trauma rooms to discover that CMV drivers were 1.87 times more likely to have severe injuries than drivers of passenger cars in similar crashes. Lack of wearing a seatbelt was labeled to be the cause of increased injury severity<sup>3</sup>. Another study found that drivers are less likely to wear seatbelts in rural areas<sup>9</sup>. Because the delivery service in this study was located in a rural area, this factor may also influence driver safety.

The second greatest cause of occupational death is in the form of falls. Due to the multilevel surfaces traversed by all employees in this service and surfaces affected by outdoor elements

Security and mental health are concerns that face all employees and employers. NIOSH and the U.S. Department of Justice found that violence in the workplace accounts for around 2 million non-fatal injuries yearly in the United States. Also reported is that workplace violence is the foremost cause of traumatic-injury death for women and second highest cause form of traumatic-injury for men on the job<sup>8</sup>. Stress caused in or out of the workplace can lead to employee ineffectiveness and inattention, therefore increasing the risk of injury or incident<sup>6,11</sup>.

## PURPOSE OF THE STUDY

The purpose of this study was to study package delivery and handling practices using naturalistic observation. After the completion of all observations, the team compiled the information to begin determining possible solutions to increase the safety and wellbeing of the employees.

## METHOD

**Research Design.** The observations were conducted to gather detailed safety data of the sorting room and driving/delivery. A total of four observations were conducted with two in the sorting room and two of delivery vans.

The first mailroom observation was conducted from 7:00 AM until 8:30 AM on a Tuesday in early December by two researchers. One of the two researchers remained in the mailroom until 9:30 AM, while the other began observation of a delivery route. The second mailroom observation was conducted the following Thursday from 6:30 AM until 8:00 AM by one researcher.

The first driving observation was conducted from 8:30 AM until 9:30 AM on the Tuesday mentioned above. Two researchers followed a delivery van from the mailroom until it returned after completing the delivery route. During the same time, two other researchers observed another van deliver mail and packages. One of these researchers observed the deliverers as they brought mail from the van into the appropriate buildings.

The two researchers in the mailroom (which include the individual following

the delivers on foot) were required by the observed delivery service to undergo background checks. Both were deemed to be acceptable persons to observe internal work processes of the delivery service.

**Participants.** In the mailroom, 14 participants were observed; 9 were male and 5 were female.

One driver and one passenger occupied each of the two mail vans observed. These four employees were all males who also worked in the mailroom and are accounted for in the total number of participants (14). In order to obtain the most natural data, researchers and participants had no personal contact or communication.

## Instruments/Equipment

**Vehicles.** Two vehicles were used to follow the mail vans. These vehicles were owned and provided by individual researchers.

**Checklists.** Two checklists were created for the use of researchers. One checklist was created for mailroom observations and the other for driving/delivery observations. These were used to keep data ordered and keep researchers in line with concurring observation.

## RESULTS

To determine possible improvements to the mailroom, observational data were collected.

### *Mailroom Observations*

**Environment.** The temperature of the mailroom was at a comfortable level. The lighting was sufficient for reading mail without any observed strain on the employees. There were three posters in plain view that defined “suspicious” packages and described the handling procedure if one was to be found. A first aid kit was mounted on a wall, but was obstructed by two mail carts, a desk, and other clutter.

The floor was cement with a glossy finish. At the very beginning of observations, there was some dust and clutter on the floor. Very soon thereafter, the floor was swept and maintained free of debris for the remainder of the observations. Three of the four sorting stations had rubber mats on the floor for employees performing static work.

Two workstations provided little room for workers to extend arms fully and one worker had sorting bins stacked such that they blocked the only exit to the station. Bins throughout the mailroom were stacked two-high at most.

The loading dock was about forty feet in length with a set of stairs on either side and a hydraulic platform lift in the middle for loading and unloading. The lift seemed to be in good working order. Some of the warning labels had been worn off and the remote operator control was always observed to be out of its lockable bin whether any work was being done on the dock. The dock was cluttered with carts and it was observed that two workers could not get to one set of stairs, so they lifted one cart and stacked it on another. Packages and two full mail bins were left unattended on the loading dock for more than 1.5 hrs.

**Personnel.** Most workers wore tennis shoes except two men who wore work boots. All workers seemed to be well rested and alert. There was an overall pleasant rapport amongst the workers.

Many cases of improper lifting were observed. The heaviest improper lift involved two men on the dock lifting one cart on top of another cart. The most common reason for bending and lifting was when workers reached into the bottom of carts to pick up or place packages.

Packages were handled separately from letter mail and divided into four cubbyholes about 5 feet off the floor, based on routing. Packages ranged from about 3 cubic cubed to about 1 cubic foot and were brought to the area in a cart about 4 feet in height. The packages were tossed into the cubbies by three male workers and two packages were noted to have fallen out after being tossed. One package that fell was caught by an employee before hitting the floor. One worker was almost hit in the head with a medium size package thrown by another worker.

All personnel used the two swinging, loading dock doors as an entrance and exit. Signs were clearly posted on the doors that they were not to be used for this purpose. No one was observed using the proper doors for entering and exiting the room. Workers were seen frequently jumping off and on the loading dock though signs were clearly posted instructing the use of stairs for safety. Delivery vans were left running and unattended at the dock while drivers were inside.

*Mail Route Observations*

After performing a series of observations, certain occurrences were noticed:

- Packages that are too heavy are left on the floor wherever there is space.
- Not all employees can lift 60 lbs.
- Some clutter.
- No dolly used after reception at mailroom.

#### *Mail Route Occurrences*

Mishandling was observed during delivery of packages to another location. In this instance, two bins and one box were delivered by the driver. Other occurrences included:

- Large boxes and full bin.
- All carried at once.
- Carried stacked one on top of another.
- Infrequent use of seatbelts.
- Very heavy items were carried to the back of the mailroom with no assistance.
- A driver appeared to struggle with the weight/size of a load being carried.

## **DISCUSSION**

After gathering and analyzing observational data, certain relationships and trends related to occupational safety and possible improvements were clear.

To begin with, bins were being stacked too high in vans and when delivering mail. This was not an isolated occurrence; during observations, bins were stacked in nearly every dolly which led to much instability. In addition, during observation, a bin stacked 4 high fell to floor; after this, the employee merely restacked it. Since bin stacking is an integral part of parcel delivery, it

cannot be eliminated; rather, in order to reduce the risk of packages falling due to improper stacking, a different solution (perhaps a new, more stackable bin) should be implemented.

Second, the clutter found in the mailrooms should be eliminated. As described by the location framework, the 3 sections to focus on for a safety hazard are the source, the path, and then the human. The area surrounding the packages seemed cluttered and short of space. In addition, there did not appear to be a designated area to place large or heavy packages (merely placed close to the door).

Third, during delivery of packages it was observed that two bins and one box were carried in at the same time. The employee appeared to struggle with the load. Observational data supports the need for a change in regard to employee assistance with package transportation.

Though there was a large amount of mail flowing through the facility, no workers seemed to struggle with their mail loads in particular. Thus, within the mailroom there may be no need to implement dollies/lifting equipment, as was hypothesized.

## **CONCLUSIONS**

The major safety concerns observed were the employees' disregard (or lack of training) for proper lifting, following posted safety instructions (signs), and use of seatbelts. To avoid injuries due to lifting, employees could be trained in proper technique and the mail service could provide lifting belts. To promote the compliance with safety instructions, an incentive system could be employed so workers have a personal reason to

change their habits. This incentive plan would also work to promote the regular use of seatbelts.

In order to obtain more precise results, more observations could have been made in the mailroom and on the delivery routes. One factor that may have influenced the study was the presence of the researchers in the workplace. Since the employees did not know the precise reason why they were being observed, many of their actions may have been changed.

### Acknowledgments

This research was approved by the Virginia Tech Institutional Review Board, and was conducted as a course assignment. All researchers on this team were IRB certified. We would like to thank Dr. Tonya Smith-Jackson for her supervision and inputs. In addition, the authors also wish to thank all participants and those who gave their time to make this project possible.

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*Check List for Mail Room*

- > Date: \_\_\_\_\_
- > Time Start: \_\_\_\_\_ Time End: \_\_\_\_\_
- > Location: \_\_\_\_\_
- > Number of employees observed: \_\_\_\_\_
- > Age: \_\_\_\_\_ Gender: \_\_\_\_\_
- > Number of packages each worker lifted: \_\_\_\_\_
- > Was Demand > Capacity? Examples?  
\_\_\_\_\_  
\_\_\_\_\_
- > Description of work layout, problems?  
\_\_\_\_\_  
\_\_\_\_\_
- > What was the observed risks:  
\_\_\_\_\_  
\_\_\_\_\_
- > How was the work flow?  
\_\_\_\_\_  
\_\_\_\_\_
- > Average time per package: \_\_\_\_\_
- > Sizes of packages(#):
  - o Small: \_\_\_\_\_
  - o Medium: \_\_\_\_\_
  - o Large: \_\_\_\_\_
  - o Other or odd shaped: \_\_\_\_\_
- > Additional comments?  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

## **DRIVING DISTRACTIONS IN PUBLIC TRANSPORTATION**

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Rohan Mathur**

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### **ABSTRACT**

The increase in fuel prices and government regulations has encouraged more people to use public transportation. With the rise in consumers, more emphasis has been placed on the safety of both passenger and driver. The purpose of this study was to determine the major distractions facing drivers and review the current training procedure for the Blacksburg Transit. Clearly, minimizing driver distraction would assist in reducing accidents caused by driver attentiveness. Based on observations of driving behaviors of Blacksburg Transit employees, our study identified several driver distractions.

### **INTRODUCTION**

The use of public transportation has increased due to its economic tradeoffs as well as environmental benefits. The rising number of passengers using public transportation has amplified risk for driver inattention. Accidents occurring on our roadways create a host of problems that negatively impact the economy and lead to a host of avoidable deaths. Through various studies conducted over the past few years, it is apparent that driver distractions have led to a great number of fatal accidents.

### **LITERATURE REVIEW**

The National Highway Traffic Safety Administration (NHTSA) has estimated that driver inattention is a causative factor in 25%-30% of police-reported traffic crashes in the US - approximately 1.2 million crashes per year<sup>(1)</sup>. An array of electronic devices, such as cell

phones and mp3 players, along with road distractions have been factors in accidents on our roads. Each year road rage and lack of sleep are identified as leading contributors to accidents. According to a study conducted by the congressional panel and the NTSB, accidents due to distractions cost the US economy close to \$4 billion dollars in lost time and litigation costs (Stutts and Hunter, 2003).

In a recent study conducted by the Virginia Tech Transportation Institute, 42,300 hours of video data was collected on drivers. In this study of 241 drivers, there were a total of 82 crashes, 761 near crashes, and 8,295 critical incidents. Of these statistics, 80% of the crashes and 65% of the near crashes involved driver inattention within 3 seconds of the event. Most common driving distractions were cell phone use and drowsiness (NHTSA).

There are several new technology breakthroughs around the country that are focused on preventing driver inattention. Currently a warning system is being developed to alert the driver of bus surroundings. In a study by Yang (2007), there were a total of 2,405 major transit bus collisions that resulted in \$15 million in property damage, 145 fatalities, and more than 8,000 injuries. He also stated that most of these accidents occurred during normal, clear and dry, weather conditions. Yang stated, “drivers are less vigilant when driving in benign conditions, such as clear weather or on straight roadways.” (Yang, 2007)

**PURPOSE OF THE STUDY**

The purpose of this study was to determine driver distractions facing the public transportation industry, as well as to provide recommendations to transit driver training protocols.

**METHOD**

**Research Design.** To determine the distractions facing each of the drivers, several observations took place detailing driver actions and attentiveness.

**Participants.** Twenty-one drivers were observed. The participants included drivers of the Blacksburg Transit bus system. Different routes and times were used to randomize drivers.

**Instruments.** An observation sheet was used in each of the trips. Glance locations and physical distractions were tallied throughout each bus ride. Glance locations included: rearview mirror, left/right mirror, instrument display, interior object, and over-the-shoulder. Physical distractions included:

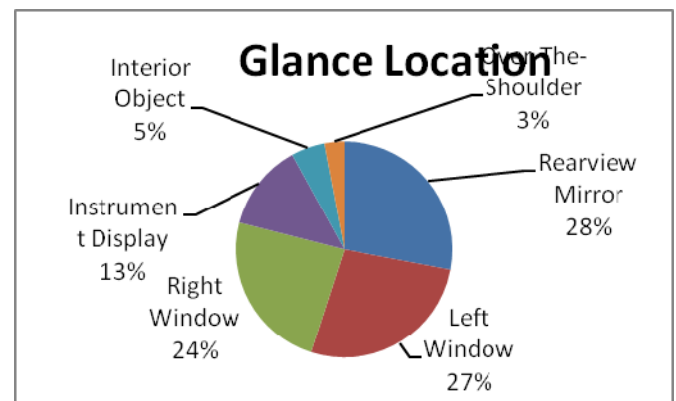
instrument display, cell phone, radio, clipboard, person (talking, etc.), running red/yellow lights, following too closely, and eating/drinking. The number of people on the bus, driver fatigue, noise level, and number of stops were also variables recorded.

**Procedure.** Each observer rode the Blacksburg Transit five times. Length of trips, bus routes, and the time of day varied among all of the rides to get a broad sample of drivers and environments. The observations were conducted unobtrusively, so both passengers, and drivers did not know they were being observed.

**RESULTS**

Results of the observations made on the Blacksburg Transit are reported here. Quantitative results were summarized and used to determine which distractions were observed most frequently (Table 1).

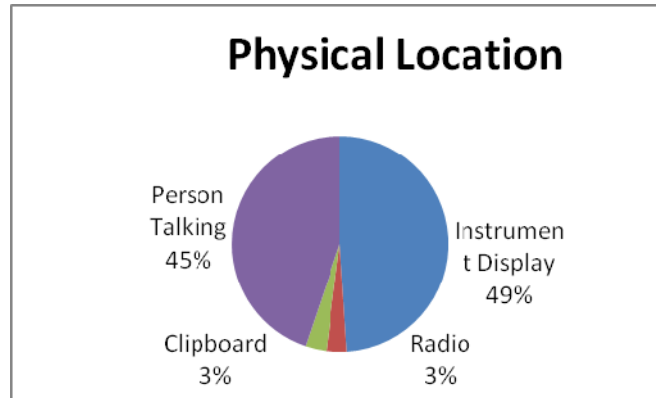
Figure 1 illustrates the breakdown of locations of participant glances. The rearview mirror most frequently the target of glances, while the right/left windows were a close second.



**Figure 1.** Glance locations.

Figure 2 depicts the physical locations the drivers looked. The instrument

display was looked at most frequently, dialoging with the driver.  
 followed by passengers who were



**Figure 2.** Physical locations.

**Table 1.**

Sample	Total time on bus (min):	Average # of People	Total Glances	Physical Distractions	Glances Per Minute	Physical Per Minute
1	22	13	49	3	2.227273	0.136364
2	27	4.5	23	3	0.851852	0.111111
3	21	9.5	34	7	1.619048	0.333333
4	18	2.5	14	3	0.777778	0.166667
5	15	7.5	38	16	2.533333	1.066667
6	30	13	45	8	1.5	0.266667
7	15	23.5	51	9	3.4	0.6
8	30	19	106	21	3.533333	0.7
9	35	21.5	61	10	1.742857	0.285714
10	30	8.5	29	6	0.966667	0.2
11	16	7.5	109	49	6.8125	3.0625
12	14	3	84	51	6	3.642857
13	11	10	105	11	9.545455	1
14	12	7.5	94	17	7.833333	1.416667
15	14	8	102	9	7.285714	0.642857
16	14	5.5	89	12	6.357143	0.857143
17	11	17.5	76	10	6.909091	0.909091
18	12	1.5	103	13	8.583333	1.083333
19	9	4.5	77	9	8.555556	1
20	15	11	94	14	6.266667	0.933333
<b>Average</b>	<b>18.55</b>	<b>9.925</b>	<b>69.15</b>	<b>14.05</b>	<b>4.665047</b>	<b>0.920715</b>

## DISCUSSION

The most common glance locations were the right and left windows, as well as the rearview mirror. In “The Five Keys to Safety”, a set of guidelines used by BT drivers, Key #2 suggests glancing forward and also towards the sides and rear to constantly update information. The BT drivers appeared to maintain their attention forward while also updating their right and left windows and mirrors. Key #2 also advises drivers to stay behind vehicles far enough to give ample time for proper decisions. Over the twenty observations, there was only one instance where the driver appeared to be following too closely. Considering the heavy traffic and busy campus environment, following too closely seems inevitable, thus making only one occurrence minuscule.

Key #3 informs the driver to keep their eyes moving at least once every two seconds. This is to prevent your peripheral vision from freezing up. The glances per minute varied from driver to driver averaging one every twelve seconds.

Though this is above the recommended two seconds, error in observation accuracy was not taken into consideration. Since the observations were done discretely, every glance could not be recorded.

Of the physical disturbances, the instrument display and conversing with a passenger occurred most frequently. Half of the conversation occurrences appeared to be involved some sort of training procedure taking place during transit with an instructor. The instrument display touches were necessary movements to operate the bus. An important note is the use of cell phones.

During all twenty observations, no instances of cell phone use were observed.

Linear regression analyses were conducted on variables recorded during the observations. Length of trip, avg. number of people on the bus, driver fatigue, and noise level were compared against each other to determine if there was any correlation between the variables and total glances or physical touches. Based on the results, we can conclude there was no correlation with glance or physical touches in relation to any of the environmental factors.

## CONCLUSIONS

Based on the results of our study, we concluded Blacksburg Transit drivers are well trained, according to the standard protocol. At no time during observation did the driver appear to be not focused on driving. The only recommendations dealt with driver route training. Having the trainer observe without talking or interfering would help the driver focus their attention on the road and give the trainer important details on true driver performance. If trainers must talk, we suggest training in which drivers train without passengers on the bus.

## Acknowledgments

This study was approved by the Virginia Tech Institutional Review Board. All researchers were certified to conduct human subjects research. The authors are grateful for the advice, laboratory use, and equipment provided by Dr. Tonya Smith-Jackson. The authors also wish to thank the following for assistance with this study:

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## **ANALYSIS OF GENERATIONAL DIFFERENCES IN OCCUPATIONAL SLIPS AND FALLS**

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### **ABSTRACT**

A study was conducted to determine if there were differences in the frequency of self-reported workplace slips and falls among younger and older workers. In addition, the study aimed to determine perceptions of slips and falls, and to make recommendations in reference to slips and falls. Twenty participants were recruited --5 men and 5 women ages 18-35 and 5 men, and 5 women ages 50 and older. Participants were asked about their experiences with slips and falls in the workplace, and whether they received any safety training to prevent slips and falls. The results indicated that older workers experienced more slips and falls, and more older workers who reported having slipped or fallen also reported sustaining an injury.

### **INTRODUCTION**

Slips and falls are a hazard that many workers are exposed to on a daily basis. This research study focused on generational differences in the frequency and injury associated with occupational slips and falls. Since slips and falls are one of the most prevalent causes of injury in the workplace today, there is a need to determine causes. This study aimed to not only determine if there is a generational difference in the frequency and injuries associated with falls, but also to determine generational differences in the perception of safety. We also explored strategies to reduce the risk of falls.

### **LITERATURE REVIEW**

A recent study stated that slips and falls in the workplace cost companies \$9.8 million a week (Yoon & Lockhart, 2006). Studies have also

reported that among railway workers, the largest cause of occupational accidents is falls and that the older the employee, the higher the lost workdays (Gauchard, et al., 2003).

Jackson (2001) noted that the highest rate of worker injuries for non-fatal occupational injuries and illnesses treated in emergency departments was found between the age of 20 and 44 with 20 year-old males experiencing the highest rate. However, another study contradicted this finding; it stated that regardless of gender, the highest rate of occupational injury is the population of workers 45 years and older. The same study further noted that time absent from work is also greater for the same population (Kemmlert & Lundholm, 2001). A third study found the 35 to 44 year-old worker population reported the most injuries; although, it was also noted that this group is proportionally

the highest employed (Yoon & Lockhart, 2006). The causes of reported slips include missteps, snow/ice, untidiness, and loss of balance (Kemmlert & Lundholm, 2001). Slippery surfaces accounted for between 40% and 50% of injuries related to falls in Europe and the U.S (Courtney, Huang, Verma, Chang, Li, & Filiaggi, 2006).

Injuries sustained due to slips typically fall into the sprains and strains categories; injuries from falls are usually fractures and bruising with the highest mortality rate found in workers age 65 and older (Yoon & Lockhart, 2006). Furthermore, in a study of restaurant workers, workers over the age of 45 reported less slippery conditions but this is believed to be a result of decreased sensory and motor perceptions (Courtney et al., 2006). This was also noted in another study, which found that degradation of sensory perceptions increased the probability of slips because of erroneous perception of floor slipperiness (Lockhart, Woldstad, Smith, & Ramsey, 2002).

### **PURPOSE OF THE STUDY**

The purpose of this study was to determine if there is a difference in the rate of slips and falls or injuries due to a slip or fall between two different generations of employees.

### **METHOD**

**Research Design.** The experiment was conducted using a 14-item questionnaire that was administered to workers with various employment backgrounds. Once the surveys were completed, they were entered into an Excel file for easy comparison and JMP for statistical analysis.

**Participants.** The participants for this project were separated into two age groups. The first group of 10 people consisted of 5 males and 5 females between the ages of 18 and 35. The second group consisted of 10 people, containing 5 males and 5 females over the age of 50. The participants had multiple dissimilar occupations and varying years of experience in their current occupations.

**Questionnaires.** The questionnaire asked participants for demographic information such as age, sex, and occupation. Participants were asked to report if they ever felt while at work that they were at risk of slipping and/or falling, how many times they had slipped or fallen, how often they felt they were exposed to slip and fall hazards, and whether they had received any safety training.

**Procedure.** The team recruited participants via word of mouth. The participants were explained the details of the study and asked if they would complete a questionnaire. Completion of the questionnaire was taken as implied consent. Once all of the surveys were completed, the data were analyzed using Excel.

### **RESULTS**

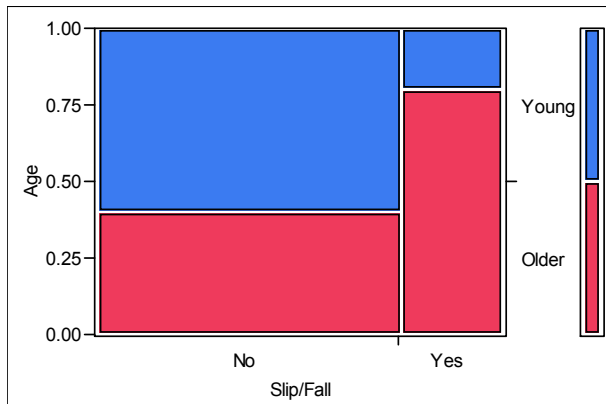
The relationship between age and the occurrence of slips and falls is shown in Table 1, indicating that proportionately more older workers reported slips and falls. A graphical representation of the slip and fall rate versus age is illustrated in Figure 1. The table and figure show that a significant proportion of the younger

population did not experience a slip or fall.

**Table 1: Slip/Fall by Age**

Count Total %	Older	Young	
No	6 30.00	9 45.00	15 75.00
Yes	4 20.00	1 5.00	5 25.00
	10 50.00	10 50.00	20

Table 2 shows the relationship between age on the perception of falling. The table shows that a significant proportion of the population that does not believe they are at risk of falling is younger and that overall the majority of both populations do not believe they are at risk of falling.



**Figure 1: Slip/Fall by Age**

**Table 2: Perception by Age**

Count Total %	Older	Young	
No	8 40.00	9 45.00	17 85.00
Yes	2 10.00	1 5.00	3 15.00
	10 50.00	10 50.00	20

Table 3 shows the relationship between safety training and the occurrence of slips and falls. A significant proportion of the population that received safety training had not experienced a slip or a fall. However, there are limitations to this interpretation, because the questionnaire did not ask when a slip or fall occurred in relation to safety training. In other words, if a person had safety training and also experienced a slip or fall, there was no way to determine which came first.

**Table 3: Slip/Fall by Safety Training**

Count Total %	No	Yes	
No	7 35.00	8 40.00	15 75.00
Yes	2 10.00	3 15.00	5 25.00
	9 45.00	11 55.00	20

Table 4 illustrates the relationship between safety training and the perceived likelihood of experiencing a slip or fall. The table shows a significant proportion of the population that did have safety training did not expect to experience a slip or fall.

**Table 4: Perception by Safety Training**

Count Total %	No	Yes	
No	8 40.00	9 45.00	17 85.00
Yes	1 5.00	2 10.00	3 15.00
	9 45.00	11 55.00	20

**DISCUSSION**

The findings provide preliminary support for the conclusion that the older population of participants experienced more slips and falls than the younger population. This is in contrast with findings from other studies such as “Jackson (2001) and corresponds with others such as Kemmlert & Lundholm (2001).

This study was limited because of the sample size, only twenty participants while other studies have used larger samples. Also, out of all participants reporting having experienced a slip, 40% were injured. Of those injured, 100% were in the population of workers over the age of 50. This is consistent with the findings of other studies such as Courtney et al. (2001).

## CONCLUSIONS

There are actions that may be adopted to prevent the occurrences of slips and falls in the workplace. According to the responses on the questionnaires, the participants attributed the occurrence of slips and falls most frequently to slippery surfaces, poor housekeeping, and carelessness. A preventative measure that can be employed in work places where floors tend to get wet would be to increase the surface roughness of the floor which will in turn increase the coefficient of friction (Chang, 1999). Specific steps can also be taken for the older population such as providing footwear that can improve balance, encouraging exercise programs, monitoring medications, and providing more training (American Geriatrics Society; British Geriatrics Society; American Academy of Orthopaedic Surgeons Panel on Falls Prevention, 2001).

Other preventative measures would include implementing stricter housekeeping standards to reduce clutter and wet spots in work areas, mandating rubber soled shoes or orthotics to improve stability, and putting signs around the workplace to remind workers to be careful. Also, special shoes should be worn for occupations that deal with snowy/icy conditions (Bentley & Haslam, 2001). While the study does provide important information about the causes of slips and falls in the work place, due to the sample size, further studies should be conducted to determine more accurately the specific causes of slips and falls in the workplace and better ways to prevent these occurrences.

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This research was approved by the Virginia Tech Institutional Review Board, and was conducted as a course assignment. All researchers on this team were IRB certified. We would like to thank Dr. Tonya Smith-Jackson for her supervision and inputs.

## **ANALYSIS OF FACTORS ASSOCIATED WITH NONCOMPLIANCE OF SAFETY PROCEDURES IN THE WORKPLACE**

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### **ABSTRACT**

The main objective of this research experiment was to identify the reasons why safety procedures/guidelines are not followed. The research team developed a simple laboratory exercise which required participants to use tools to build an item. The participants were given safety instructions on how to build the item properly and safely. The participants faced various factors in completing the task, such as time constraints and a monetary related prize for best performance. After the exercise was completed, the researchers inquired as to why or why not the participants chose to follow the safety procedures/guidelines they were given.

### **INTRODUCTION AND PROBLEM**

In the working industry, employees are given tasks everyday to complete. With these tasks comes the possibility for injury. Since these tasks are often dangerous, employees are given safety procedures/guidelines to follow. Safety procedures are put in place to prevent and reduce the risk of injury of an individual and of those around them. Unfortunately, injuries often occur on the job because an individual fails to properly follow safety procedures. If the safety procedures are not followed in the way in which they were presented, the likelihood that an injury or death occurs increases. If these rules are not followed, then the question is, why not? This study will look at this problem in greater detail and try to provide more clarity to this issue.

### **LITERATURE REVIEW**

Compliance of safety rules in the workplace are critical for preventing injuries and fatalities as well as improving job quality and efficiency. Employees, who report high perceptions of job insecurity, exhibit decreased safety motivation and compliance (Tahira and Brubaker, 2001).

Levels of risk perception vary depending on each individual. Individuals with the same level of risk perception might have different levels of risk-taking behavior (Thongsamak, S., 2007, p32). Social (Kasperson, 1992), cultural (Rayner, 1992), and psychological paradigms (Slovic, 1992) have been introduced as the major factors of risk perception. Simard and Marchand concluded that the primary determinants of the propensity to safety compliance behavior are the micro organizational factors (SIMARD and MARCHAND, 1997). Hayes introduced that the Work Safety Scale subscales were logically

related to job stress, psychological complaints, physical complaints, and sleep complaints (Hayes et al., 1998). The aim of this project was to see if the research team could find similar results and trends that have been seen in previous studies. The research team has identified potential factors that they believe will contribute to the noncompliance of safety procedures.

Time constraints were expected to be the main reason for noncompliance. This can be seen in another study done by Hecker. Those in workgroups in Hecker's study discussed the value of spending more time and money directed towards safety. A major issue that came up dealt with "the challenge of balancing competing goals"—increasing safety vs. timely job completion and cost (Hecker et al., 2005). The research team recognized that identification of these factors would not be a stopping point. Once the factors were identified, the researchers had to do something with them. A study done by Lingard notes tools that can be used to help increase safety awareness. Effective tools include designing, preplanning, training, management commitment and the development of a safety culture (Lingard, 2004).

#### **PURPOSE OF THE STUDY**

In industry, many standards and technical regulations are established to protect workers' safety. Such standards and technical regulations can, however, substantially raise both companies' start-up and production costs. On the other hand, not having these standards or altering a workers behavior may increase the risk of injury. Therefore, the purpose of this study is to identify

factors associated with noncompliance of safety procedures. Once these factors were identified it was also important to figure out what can be done to reduce these hazardous actions.

#### **METHOD**

**Research Design.** A laboratory experiment was designed to help determine what factors lead to the noncompliance of safety procedures. The experiment was a simple construction related task that had participants use basic hand tools. Safety questionnaires were used to get an understanding of how participants viewed safety procedures and how confident they felt about their ability to complete the task.

**Participants.** The researchers were able to recruit 17 participants for this study. Participants ranged in age from 19 to 35. The mean age for participants was 26 with a standard deviation of about 5. Also, there were 11 males and 6 females. It is important to know that 59% of the participants were Caucasian while the remaining 41% were Asian. All participants were recruited from the Virginia Tech campus. Both graduate and undergraduate students took part in the experiment. To ensure the validity of the results, only subjects with no apparent musculoskeletal disorders were allowed to take part in the experiment.

#### **Instruments.**

**Questionnaires.** Multiple questionnaires were used to gauge how each participant felt about safety. These questionnaires included a demographic survey, a safety self

efficacy test, a risk perception scale, a locus of control, and a safety locus of control.

**Equipment.** The researchers used four pieces of wood that were to be assembled into a frame. In addition to the frame, two blocks from another type of wood were used. Participants used the following tools to complete the experiment: a hammer, handsaw, vice grip, straight edge, nails, and a tape measure. Personal protective equipment (PPE) was also provided in the form of safety glasses, gloves, and ear plugs.

**Interview Questions.** Each participant was asked a few questions after the experiment was complete. These questions inquired about his or her feelings during the experiment, why PPE was used or not used, and how each participant felt about the safety equipment.

**Procedure.** When participants arrived at the lab, researchers gave them the informed consent form and went over it. After that was signed, the participants were asked to answer all the safety questionnaires. Upon completion of the questionnaires, the researchers then explained in detail what he or she was expected to build. A blueprint of the frame was given to the participants. On this blueprint, the nail locations were labeled, as well as the size and location of the two blocks that needed to be cut and nailed to the frame. Participants were told that they would be given 500 points to start out with. The researchers decided to give each participant seven minutes to completely finish building the frame. It was explained that one point would be deducted for every second

that the participant exceeded seven minutes. One point was also deducted for every one-sixteenth of an inch off in measurements. The researchers also explained how to properly use the PPE that was provided.

The participant then started the experiment. During this time, the researchers kept the time with a stopwatch and announced one minute intervals, while observing the participant. Notes were taken as to whether or not the participant used any PPE. After the experiment was completed, the researchers conducted a short interview to find out why the participant used or did not use the safety equipment. When the interview was complete, the participant was free to leave and the researcher would evaluate the participant's performance.

## RESULTS

Data from the questionnaires were analyzed by using Excel and SAS JMP 6.0 software. To see the difference of two groups, T-tests were used setting the power level at 0.05.

1. PPE Usage Rate  
During the experiments, 10 out of 17 (58.82%) participants used safety gloves and 12 (70.58%) people wore the safety glasses, while only 2 (11.76%) subjects used earplugs for their safety.

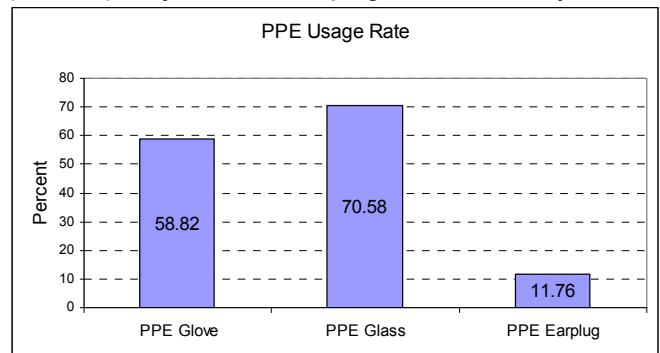


Figure 1.1. PPE Usage Rate (Gloves, Glasses, Earplugs)

2. Reasons of noncompliance of Safety Procedure

The main reasons why people compromised their safety were identified from the results of post-experiment interviews. Six participants answered that the task itself didn't call for use of personal protective equipment and another six people replied that they did not use PPE due to time pressure. Uncomfortable PPE, for example, the gloves were too big and made it hard to grab the nail, led five participants to not follow the safety instructions. Also, someone said that he or she forgot to use PPE, while another participant said that he did not use safety glasses because he thought his prescription glasses could protect his eyes.

3. PPE Usage Scale

Each participant had their score (gloves: 4 points, glasses: 4 points, earplugs: 2 points, partial use: -1 point) based on the PPE he/she used during the experiment.

Gender Factor

We divided the subjects into two groups based on their gender. The male group (5 males) had a mean of 3 while the female group had a mean of 5.5. However, the difference of the mean scale between the two groups was not statistically significant according to the t-test.

Age Factor

In order to see the age factors, two groups were set based on their age. Group A (mean age = 20.2, 19-21) had 5.8 of mean scale while the mean scale of group B (mean age=33, 31-35) was 5. Like the gender effect, we could not find the age effect in the PPE usage scale to be significant.

4. White Male Effect

The White male effect is the tendency of white males to fear all manners of risky behavior less than women and minorities (Finucane 1999). To see this effect, we divided the subjects into a white male group and a non white male group. The risk perception scale was used like in Finucane's study. The white male group (mean age=24.8, 5 males) had a mean of 6.58 (s.d: 1.09) while the non white male group (6 Asian males, 1 Asian female, 5 Caucasian females) had a mean of 7.02 (s.d: 0.97). However, the difference was not significant by the T-test at  $\alpha=0.05$ .

Instead researchers found the difference in the PPE usage scale mean between two groups.

One had a mean value of three, while the other group almost doubled the score of the white male group.

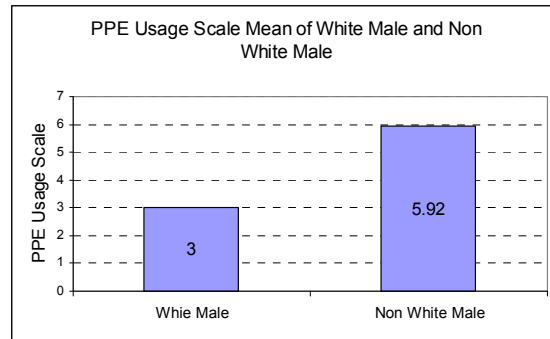


Figure 4.1. PPE Usage Scale Mean

However, according to the result of T-test as shown below, the difference was neither significant in the mean of PPE usage rate nor consistent with "White Male Effect".

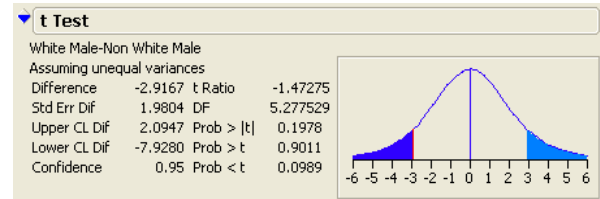


Table 4.1. The result of t test in the mean of PPE usage Rate

Finally, the researchers found a significant difference between two groups in the mean of safety self efficacy by the t-test at  $\alpha=0.05$ . Safety self efficacy is the score on a one to ten scale that represents the confidence regarding the safety procedure.

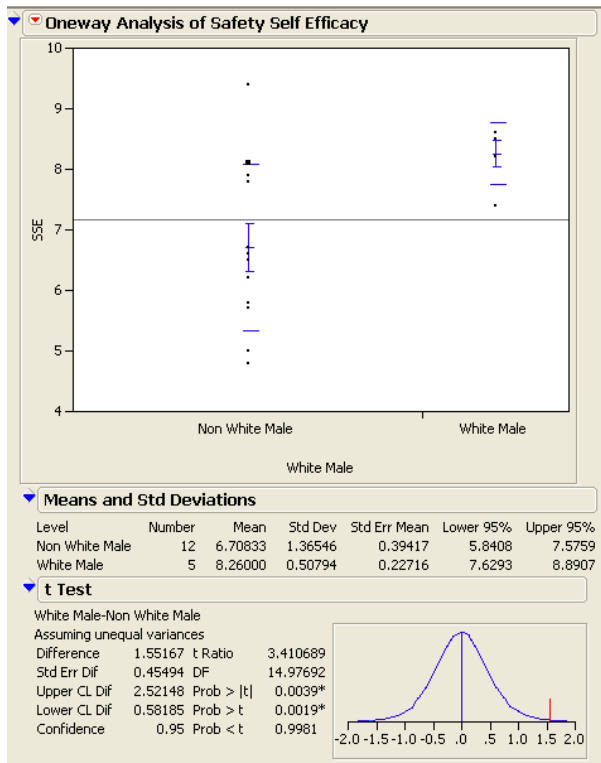


Figure 4.2. The result of Self Safety Efficacy

### DISCUSSION

The results of PPE usage rate show that safety glasses and safety gloves were used by the majority, while only a limited number of participants used the earplugs, since the environment of this experiment wasn't loud enough to need them. To answer our research question of why there is noncompliance of safety procedures, we found that many people do not use PPE due to time pressure and uncomfortable PPE.

In the PPE usage rate and risk perception rate, researchers could not find a gender effect or an age effect, which was inconsistent with Finucane's study. When the group was divided based on age, gender could not be controlled due to the limited human subjects. This gender factor could have been confounded in the result.

The results of both the risk perception rate and PPE usage rate were not consistent with the "White Male Effect." However, the white male group had a 24.8 average age, and we had only Asians and Caucasians in the non white male group. For a better result, there should have been younger white males and different racial groups, like African-Americans and Hispanics.

We found a significant difference in the mean of safety self efficacy between two groups, which tells the researchers that young white males are more confident in the safety procedure than women and minorities. Because others did not use safety self efficacy for the "white male effect" in their studies, it is believed that this is a new finding. However, this significant difference could have been due to the confidence with the English language. All the safety instructions were given in English and every White male spoke English as their first language, while some (7 people) of other participants spoke English as a second language.

### CONCLUSION

From the findings of this study, the researchers were able to see that time pressure and uncomfortable PPE were the main causes of noncompliance. Since companies in industry are more than likely faced with this same issue, the researchers have a few recommendations on how to limit the risk of noncompliance. The first would be to invest in proper and comfortable PPE. It would be worth the investment because workers would be more likely to wear it and wearing PPE greatly reduces the risk of injury. A second

recommendation would be to make sure every employee goes through the proper amount of training. Safety should be talked about at the beginning of each workday, so all the workers have it fresh in their minds. If the workers hear about safety everyday, then they will be less likely to take shortcuts caused by time pressures and other factors.

One of the main limitations of this study was the lack of diverse backgrounds. Future studies should try to include more participants with a greater range of ethnic backgrounds. Also, this study focused on participants that were of the college age. To get a better understanding of how age may affect how safely a worker performs his or her job, participants need to be recruited from outside of the college campus.

#### Acknowledgments

This research was approved by the Virginia Tech Institutional Review Board and was conducted as a course assignment. All researchers on this team were IRB certified. We would like to thank Dr. Tonya Smith-Jackson for her supervision and input. In addition, the authors also wish to thank Dr. Brian Kleiner for allowing the researchers to use his lab.

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