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An Examination of the Day of Week and Sampling on Injury Occurrence

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DEDICATION

This thesis is dedicated to all my friends

and family who asked me:

“So, how’s your thesis coming along?”

ACKNOWLEDGMENTS

First, I want to thank Eastern Kentucky University's College of Justice and Safety for accepting me into their graduate program, and affording me every opportunity to succeed. The facilities and staff are second to none, and I have never been without the adequate materials or technology needed to perform thorough and accurate research.

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Last, I'd like to thank my committee of Scotty Dunlap, Sarah Adkins, and Barry Spurlock. They were all willing to take time out of their busy schedules to help guide me during my research, and a lot of credit for the completion of this study goes to them.

ABSTRACT

This study hoped to answer two questions: first, when trying to determine on what days of the week saw an increase in reported injuries within the central region of XYZ Distribution, could a small, random sample be pulled from the region, and proved to be statistically similar to the region as a whole, allowing it to be studied with accuracy; and two, was there a significant difference in the number of injuries when comparing days of the week that could allow the company to focus their resources in an attempt to lower incident rates? In order to answer those questions, 375 random cases were selected from a total of over 17,000 injuries covering a 30 month span, and statistical analysis of variance was applied.

The first test measured to see if the random selection of participants was a valid data set by performing a one way analysis of variance to measure statistical significance. The ANOVA showed a significance level of .277, well above the alpha level set of .05, meaning there is no statistically significant difference between the two data sets. The second analysis of variance was used to measure the difference in injuries reported on different days of the week. The results showed all five days measured falling well within the 95% confidence interval for mean, meaning that there was no significant difference for the amount of injuries reported when looking at days of the week. To conclude, a Scheffe post-hoc test was performed, and confirmed that not only is there no difference when measuring injuries on days of the week, there's not even a statistically significant difference when measuring the day that saw the most injuries reported against the day that saw the least amount of injuries reported.

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CHAPTER I

INTRODUCTION

This study will focus on what day of the week employees are most likely to become injured within the central region of XYZ Distribution. I was an employee of this company from December 2007 to August 2013, and held several positions. Eight months after being hired, I was promoted to the position of Frontline Supervisor on the afternoon sort where I learned the basics principles of safety and supervision. After two and a half years operating an outbound belt, I was trained to become a Hazardous Materials Supervisor, where I oversaw the clean-up and proper disposal of all broken or damaged items. After one and a half years at that position, I enrolled in the SSEM Graduate Program at EKU, and transferred to the early morning sort as the safety supervisor. My responsibilities in that position included training of both hourly and management employees and maintaining monthly and yearly safety paperwork. It was during this time, while also taking graduate classes at EKU, that I became interested in studying the safety of the employees at XYZ a little further. I saw, firsthand, the amount of money and effort that XYZ put into their safety program, and I began to wonder on what days of the week our employees were the most vulnerable and likely to become injured. Was it at the beginning of the week when volume was heaviest, or was it near the end of the week when inattentiveness and fatigue set in? XYZ prides itself in their ability to keep safety interesting for employees with events such as prize giveaways for depth of knowledge mastery and celebration of safety milestones. A lot of time and effort goes

into preparing pre-work demonstrations, or random prize giveaways for over 150,000 employees spread throughout the United States. In spite of all this work and effort, the central region still logged 17,742 weekday injuries in 30 months, or about 29 per working day. It is my hope that this research can help the company recognize if there is a significant difference in injuries on certain days, and if there is, XYZ management can focus their efforts on these days in an attempt to keep employees safer. Specifically, the purpose of the research is to determine if we can accurately predict when employees will most likely become injured by randomly selecting a small number of injuries and comparing it to the central region as a whole. If we can indeed accurately predict higher risk days, is there a significant difference between incident rates when comparing each day?

Background

The study of workplace injuries by day is a valuable research tool when attempting to predict and prevent injuries. All industries, workers, and locations face their own unique challenges and obstacles, making it impossible to accurately predict an injury for one occupation or area by combining all the information. Studies have been performed using states, even nations as a whole, to compare injuries for days of the week, but there is very little in the way of studying only one business. By analyzing the data from XYZ Distribution exclusively, it would be possible to produce a plan that helps reduce the significant number of injuries the company reports every year. The data will be analyzed in the form of a one way analysis of variance.

The one way analysis of variance, or one way ANOVA, is a technique used to compare the means of two or more samples. The ANOVA tests the null hypothesis that samples in two or more groups are drawn from populations with the same mean values (Howell, 2002). This type of cross validation is mainly used in statistics when the goal is prediction. By comparing a random set of data pulled from the central region to the known population, we will be able to give insight on how the randomly selected data will generalize the central region data as a whole. If our randomly selected data set proves valid, we can determine if there is a statistically significant difference in incident rates on different days of the week.

Statement of the Problem

XYZ Distribution spends well over $120 million every year on safety training in order to keep employees safe, and keep employee injury related cost to a minimum. This training involves dealing with hazardous materials, how to recognize heat illness, and basic ergonomics, just to name a few; but every year, thousands of injuries are reported nationwide by XYZ. The expense of medical visits, rehabilitation, and workers' compensation cost the company hundreds of millions of dollars per year, a cost that is passed on to the consumer through yearly price increases. The XYZ safety program, in spite of having a high budget, is still ineffective in significantly lowering employee injuries. By identifying what day of the week employees are most likely to become injured, resources can be focused on certain days, and efforts can be made to lower incident rates.

Purpose of the Study

The study, covering information from January 2010 until June 2012, produced 17,742 weekday injuries within the central region of XYZ Distribution, and identified the type of injury, time of injury, day of injury, the job of the employee, and the length of service of the injured employee. By testing 375 randomly selected injuries against the central region as a whole, we can measure if accurate prediction for which day will produce the highest rates is possible, and to measure any significant difference between days; the purpose of this being to help keep cost down, and to reduce the chances of potentially serious injuries.

Potential Significance

If our data does accurately predict which day employees are most likely to become injured, and we determine that there is a statistically significant difference in the number of injuries during different days, the information will help smaller business units - especially those who do not have enough information about their injury history - focus time, energy, and resources to days in which they may not have realized they were at risk. The average cost of an injury for the central region of XYZ Distribution is $7,276. If the injury is severe enough that an employee is forced to miss days at work, the average cost will rise to over $20,000. By lowering the incident rate in the central region by a mere 10%, XYZ distribution will save over $13,000,000 per year. These savings will help

keep prices lower for customers, benefits higher for the employees, and could potentially prevent a serious and debilitating injury.

Definition of Terms

Confidence Interval - A type of interval estimate of a population parameter and is used to indicate the reliability of an estimate.

Confidence Level - Refers to the percentage of all possible samples that can be expected to include the true population parameter.

Cross-Validation - Sometimes called rotation estimation, is a model validation technique for addressing how the results of a statistical analysis will generalize to an independent data set.

Days Away/Restricted Time – Number of separate cases with days away from work or job restriction/transfer.

Incident -Also known as injury or illness.

Lost-Time Injury - An injury that requires an employee to miss at least one day of work due to their physical restrictions.

Post-Hoc Analysis - In the design and analysis of experiments, post-hoc analysis consists of looking at the data—after the experiment has concluded—for patterns that were not specified a priori.

SPSS – Statistical Product and Service Solutions is a software package, designed by IBM, used for statistical analysis.

Assumptions

The study kept assumptions limited in order to provide the most accurate data. The following assumptions were made: first, the information was correctly and accurately entered into the XYZ safety system by the responsible supervisor of the injured employee. Second, employees who were injured did not ignore the injury, and reported the incident to management. Third, employees were honest about the details of their injury, and did not providing false information. Fourth, we assume that the insurance provider who collected the data not only received all the information needed for an accurate study, but that they also provided an error free analysis. In order to perform the one way analysis of variance, we must assume that the population from which our samples were obtained is normally distributed, the samples are independent, and the variances of the population are equal (Lowry, 2013).

Limitations

The limitations of this study included preexisting data and records that only dated back to June 2012. No further information was able to be gathered after that date to determine if the trends shown in this data continued on into following years. Normally, a major limitation when performing a one way ANOVA is that the researcher does not

know how the means differ, only that they are not equal, however , this limitation is remedied by performing the Scheffe post-hoc test.

Organization of the Study

Information includes summarization of the randomly selected cases from the central region data, the day of the week each injury occurred, cross validation between the two sets of data, and the accuracy of the test. Accuracy was ensured by performing a one way analysis of variance between the two data sets within SPSS. Post-hoc analysis measured any statistical significance between days of the week and injuries in order to gain a better understanding of the statistical difference of injuries reported on each day.

CHAPTER II

REVIEW OF THE LITERATURE

Existing literature formed the basis of this study, and the hope that identifying high risk days will help lower injury rates and cost. Some of the literature is dated, and many show different results, but the results will help employers within the same industry or geographical area focus on which days their employees are at the highest risk of injury. While the way we perform certain jobs in industry has changed dramatically, the risk of injury will always remain.

National Studies

The study of injuries on certain days of the week has been performed before in varying occupations and conditions, many with different results. One can hypothesize that injuries happen earlier in the week when fatigue from the weekend is still high. The middle of the week brings 'the hump' in which many employees could become distracted and frustrated, especially if the employee has had a difficult beginning to the work week. The end of the week brings inattention due to thoughts of weekend plans and activities, and working on the weekend can bring unhappiness and anger due to missing time with friends and family. The latter was confirmed in a study done in 2007, based on information collected from the Bureau of Labor Statistics (BLS) for 2004. The study reviewed both overall injury numbers and lost time (LT) rates for the United States. For overall injuries, Saturday and Sunday proved to have 2 of the 3 highest incident rates,

with Sunday being nearly 37% higher than any other day. For females, not only were the injury rates higher, but the LT rates were significantly greater on the weekend than during the week: Sunday and Saturday showed a 122% and 60% higher rate for LT injuries than the weekly average (Brogmus, 2007). Industry, fraud, and overtime could not be confirmed in this study.

The United States is not the only country to perform a study concerning the injuries and on certain days of the week. Queensland, Australia collected over 750,000 workers' compensation claims filed by male workers from 1968-1988 for the purpose of investigating some possible reasons for the increased number of claims at the beginning of the week (weekends were not included in the study). Of the 750,000 claims, 23.6% of injuries fell on a Monday, and rates fell every day of the week, ending with Friday at 16.3% (Wigglesworth, 2006). The study also showed higher incident rates in the morning for every day of the week, and Monday morning proved to be the most dangerous period during the week.

Local Studies

Research of this kind has been performed on more of a local level, as demonstrated by the state of Wyoming in a 2007 review. In December 2006, state officials informed 2,700 private industry employers to keep solid and accurate records of all their incidents for 2007. For the year, the estimated private sector incidence rate in Wyoming was 4.6 injuries and illnesses per 100 full-time employees. The study shows

that based solely on occupational injuries and illnesses involving days away from work, Thursday showed the highest rate with 720 of the 3,420 total cases, or 21.1%, and was 10% higher than the next closest day (Davis, 2009). Interestingly, the previous three years showed that Wednesday had the highest incident rate for Wyoming concerning LT injuries.

The District of Columbia's Annual Survey of Occupational Injuries and Illnesses for 2009 was collected by local government officials, and showed that there were 3,090 work-related injury and illness cases reported in the private industry that required days away from work. The Washington, DC Department of Health concluded that of the 3,090 incidents, Wednesday held the highest number of injuries with 630, or 20.4%. Monday followed as the second highest day with 520 cases, or 16.8% (Turner, 2010).

The state of Kansas performed a more recent study within the 2011 private sector. Data was collected form 3,500 randomly selected employers, and was analyzed by the Kansas Department of Labor. Employees in these businesses recorded 34,400 nonfatal workplace injuries and illnesses in 2011, giving them an incident rate of 5.4 per 100 full-time workers; of those claims, 8,570 cases required days away from work. For the LT injuries mentioned, Wednesday and Thursday showed the highest incident rates with 21.1% and 19.4%, respectively (Hersh, 2013). This study further broke down incidents into time of day, and how long the worker had been on the clock before getting injured. Almost 50% of injuries happened between 8 A.M. and 4 P.M., and workers on the job four to six hours accounted for nearly 20%, by far the highest rate.

Montana studied characteristics of occupational injury data in 2011. For the year, Montana, with a population of less than 1 million, employed approximately 403,400 and reported 13,200 nonfatal occupational injuries or illnesses. This gave the state an incident rate of 5.0, as compared to the United States incident rate of 3.5 for the same year. A hypothesis for the higher rate is Montana's high employment in agricultural, forestry, fishing, and hunting, all of which pose increased risk for injuries due to exposure to weather and environmental hazards. When broken down by days, all of the week days were very close in the number of injuries, but Friday showed the highest rate with 18.9% of all injuries, followed closely by Wednesday with 17.9% (Coggeshall, 2011).

In 2012, the Louisiana Workforce Commission collected and analyzed their injury and illness information into several categories, including the time of the event, hours on the job before the event occurred, and the day of the week of the incident. Of the 10,030 non-fatal injuries that Louisiana employers reported for 2012, the following trends showed that the most injuries occurred between 8:01 A.M. – 12:00 P.M., with 27.2% of incidents. 18.9% of injuries happened between two to four hours after the employee was on the clock. Finally, Wednesday showed the highest rate of injuries 2,050 of the 10,030 injuries, or 20.4%, and was followed by Friday with 1,710 injuries, or 17% ("Number of nonfatal," 2013).

As can be seen from the literature, the highest risk day depends on a number of factors: the length of the study, the location of the study, and even the randomness of

employer selection. Each study found varying results, indicating that while many hypotheses and theories exist as to which day produces more injuries, it is difficult to predict, and can vary country to country, or even state to state. While many studies exist involving the research of states and nations, analysis of one business or industry is limited. With such a large data set from XYZ Distribution, it might be possible for not only smaller units within XYZ to reduce injury, but for other companies within the same line of work to accurately predict the occurrence of injuries.

CHAPTER III

METHODOLOGY

The methodology of this study included the collection and examination of pre-existing injury information from the central region of XYZ Distribution. Immediately after the employee claims they have been injured on the job, the incident is entered into the company's injury system by the affected employee's direct supervisor as accurately as possible.

Selection of Participants

Participants include only those employees who worked within the central region of XYZ Distribution that reported an injury to their supervisor, and that it was deemed serious enough for treatment beyond first aid. For the purpose of recordkeeping, incidents would include visits to a medical professional in which treatment beyond first aid was necessary, injuries that required restricted work duties or job transfer, and lost time incidents. There were no fatalities reported within the data set for the 30 month period. The records that were analyzed do not include any employee information; this includes employee identification numbers or gender. No effort was or will be made to identify any of the affected employees, and no interviews were conducted.

Research Questions

This study compared a random selection of data against the central region population to determine if the random data proved valid. The study will determine if by randomly selecting data from the collected information, one could accurately predict on which day of the week an employee was most likely to become injured, and if there was significant difference between the days. With the selection of 375 individual cases, we can estimate which day shows the highest risk of injury with a 95% confidence level.

Data Collection

When an employee became injured, their responsible supervisor would input the data into XYZ's safety data collection program. Every 30 months, the information was collected and analyzed by XYZ's insurance provider, and the data was sent to the company's safety department. The data used for this research covers 17,742 weekday injuries reported over the 2.5 year period. If an employee reported multiple injuries within the time of Jan 2010 until June 2012, each injury would show as a separate case.

For our randomly selected data, all 17,742 injuries were entered into a Microsoft Excel worksheet, and the 'rand' function was used to randomly select 375 cases. For the purpose of this study, only injuries that occurred on Monday, Tuesday, Wednesday, Thursday, and Friday were used. Injuries that were reported on Saturday or Sunday made up less than two percent of the incidents, and were removed. XYZ distribution only

operates on the weekends during the final five weeks of the year. Therefore, weekend injuries were removed to avoid skewing the results.

Data Analysis

Each employee case is masked by a generic number, 1-17,742, as provided by XYZ's insurance provider. After using the random number generator within Microsoft Excel, the data was input to SPSS software where a one way ANOVA was performed the results were provided. SPSS also provided a post-hoc analysis, comparing each day of the week against the other four days.

Subjectivity and Bias

Bias was not present in this study as the sole purpose was to determine if the random data set could be validated against the entire central region, and if there was a significant difference between injuries and days of the week, both of which could help XYZ Distribution predict or determine which day their employees are at the highest risk of injury. Personal bias was avoided in research and analysis as the information was collected by XYZ's insurance agent; also, the 375 cases used for cross validation were not selected by the researcher, but produced by a random number generator within Microsoft Excel, and the results of the one-way analysis of variance is provided in Table 1.

CHAPTER IV

RESEARCH FINDINGS AND ANALYSIS

After the one way analysis of variance was run by SPSS between the 2 groups of data, and the results were provided as shown in Table 1, you can see that the significance level (Sig.) is .277, which is well above the significance level of $\alpha = .05$. This means that there is no statistical significant difference between the randomly selected injuries when measured against the central region as a whole.

Table 1. Comparison of Random Sample Against Central Region Population

	Sum of Squares	df	Mean Square	F	Sig
Between Groups	9.349	4	2.337	1.29	.277
Within Groups	239.191	132	1.812		
Total	248.540	136			

A one way analysis of variance was performed comparing the average number of injuries per day over the 30 month period as shown in Table 2. As the table shows, the mean for each day falls well within the 95% confidence interval for mean, indicating that there is not a statistical significant difference in injuries when trying to determine if one

day produces more injuries than another day. Out of the 30 months, N represents how many months out of those 30 recorded an incident.

Table 2. Mean Number of Injuries Reported on Each Day

	N	Mean	Std. Dev	Std. Error	95% Lower	95% Upper
Mon	27	2.48	1.156	0.222	2.02	2.94
Tue	28	3.04	1.453	0.274	2.47	3.60
Wed	27	3.07	1.492	0.287	2.48	3.66
Thu	29	2.55	1.429	0.265	2.01	3.10
Fri	26	2.54	1.140	0.223	2.08	3.00
Mean	27.4	2.74	1.352	0.115	2.51	2.97

The final test run was the Scheffe post-hoc test, which compares each day to the four other days. While Table 2 showed us that there was not a significant difference in the average number of injuries for each day, it also does not show a statistically significant difference when comparing the day with the highest amount of injuries (Tuesday), and the lowest amount of injuries (Friday). When run, all days were measured against the other four, and as the post-hoc test shows in Table 3, all significance levels measure above .05, meaning there is no significant difference in the number of injuries when looking at days of the week.

Table 3. Scheffe Post-Hoc Test Comparing Day of the Week Against Other Days

Day	Comparing to	Mean Difference	Std. Error	Sig.
Monday	Tuesday	-0.554	0.363	0.676
	Wednesday	-0.593	0.366	0.625
	Thursday	-0.070	0.360	1.000
	Friday	0.554	0.370	1.000
Tuesday	Monday	0.554	0.363	0.676
	Wednesday	-0.038	0.363	1.000
	Thursday	0.484	0.357	0.765
	Friday	0.497	0.367	0.765
Wednesday	Monday	0.593	0.366	0.625
	Tuesday	0.038	0.363	1.000
	Thursday	0.522	0.360	0.717
	Friday	0.536	0.370	0.718
Thursday	Monday	0.070	0.360	1.000
	Tuesday	-0.484	0.357	0.765
	Wednesday	-0.522	0.360	0.717
	Friday	0.013	0.364	1.000
Friday	Monday	0.057	0.370	1.000
	Tuesday	-0.497	0.367	0.765
	Wednesday	-0.536	0.370	0.718
	Thursday	-0.013	0.364	1.000

CHAPTER V

DISCUSSION AND IMPLICATIONS

Discussion

At the beginning of the research, I hoped to answer two questions: first, when trying to determine what days of the week caused more injuries within the central region of XYZ Distribution, could a small, random sample be pulled from the region, and proved to be statistically similar to the region as a whole, allowing it to be studied with accuracy; and two, was there a significant difference in the number of injuries when comparing days of the week that could allow the company to focus their resources in an attempt to lower incident rates?

For the first question, 375 random injuries were selected from the 17,742 injuries that the central region reported over the 30 month period from January 2010 to June 2012. When cross validated against each other, the small data set proved to have no statistically significant difference when compared to the entire region. What this proves is that a safety supervisor, whether they are employed by XYZ Distribution or by another company, the researcher may not need to study large amounts of data when trying to analyze their injury statistics. If an appropriately sized (according a sample size calculator), truly random sample is taken from a large database, a company can save significant man hours and resources by studying a much smaller sample in attempts to lower their incident rate. For the second question, while there were differences in the

number of injuries recorded for each day of the week, there was not enough of a difference in the rates for each day to be considered statistically significant. This prevents XYZ management from being able to justify directing extra time and resources towards one specific day in an attempt to lower injury and illness rates, and frees up leadership to pursue other means of research in order to do determine the root cause for the company's injuries.

While the data shows that there is no statistical difference in the days of the week, as a former employee, I believe that there is a practical difference when looking at certain days of the week and when injuries occur. The data strictly shows the number of injuries logged over the 30 month period, but it does not take into account the amount of work volume and the number of employees that are working during different points of the year. For example, more than 25% of the yearly volume is processed in the months of November and December for XYZ, with Monday-Wednesday being the busiest part of the week. In Appendix 1, the data shows that in those two months for 2010 and 2011, early week injuries appear to be higher than they are throughout the rest of the year. These numbers are evened back out throughout the other ten months when injuries on those days seem to be more in line with Thursday and Friday. While the rest of the year shows little difference in days of the week and injuries, XYZ could possibly benefit from concentrating on high volume days during their peak season when more hours are worked, more volume is moved, and more drivers are placed on the road.

While the study disproved any significant difference in injuries and work days within the central region of XYZ Distribution, the idea remains valid. As the literature showed, states, and even nations have provided information of what days their employees face the most risk, and if that research helps to keep even one employee safe and working, the result was well worth the effort.

Recommendation

The disadvantage of analyzing the entire 30 months period is that while I was able to compare days, I am unable to compare different periods of the year when the company may be busier or slower. My recommendation would be to further study the peak months of November and December when work volume and number of employees working are at their highest. Lowering injuries during this period can help maximize earnings during an already profitable period, and could possibly keep employees from being injured during the holiday season.

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