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APPLICATION OF TEST HYPOTHESIS WITH DIRECTIONAL ALTERNATIVES IN TRAFFIC OFFENCES – NIGER STATE EXPERIENCE

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ABSTRACT

The world today is faced with the problem of road accidents. This is mostly due to inadequate traffic management and law enforcement, poor road condition, reckless driving, over loading, unsafe condition of machinery (vehicle) and so on. This paper compares these differing traffic offences using hypothesis with directional alternative. The data used in this study were extracted from Niger state statistical year book (2004) and the computation was done with Statistical Package for Social Science. The result shows that offences do not significantly different from one another. Hence, Federal Road Safety Commission (FRSC) should always look into all these offences with the same form of seriousness.

Keywords: Road Accidents, Traffic Offences, Directional Alternatives, Niger State and Vehicles.

INTRODUCTION

Road accident has become one of the most common causes of death and injuries which result in many economic and social problems. Like many other countries of the world, Nigeria has an accidents register which contains information that is provided by the law enforcement agency. This register has common features and it contains large number of variables (Hananiyah, 1998).

Today, road safety accident is a dominating issue in all places. It has resulted in many personal injury or property damages. The basic causes of road accident in Nigeria are the general unsafe condition of machineries (vehicles), drugs abuse, reckless driving and others. In view of this and many other reasons, the Federal Government views it as its responsibility in addressing the ugly situation by advocating a preventive measure. As a consequence, the Federal Road Safety Commission (FRSC) was established. The commission was charged with the responsibility of policy making, organization and administration of road safety in Nigeria (FRSC, 1995).

This paper is mainly concerned with the application of test hypothesis using directional alternative in road traffic offences. It is possible that one offence is most significant than another. Therefore, it is of interest to study the significance of different offences as they contribute to road accident on the highways.

The government, insurance agencies and vehicle manufacturers have tested and researched side impacts collisions. The result of these tests was the development of side airbags. If they are used properly, they can save a life. Injuries from side impacts are most often heads, necks, dislocations, chest, arms and legs. This is in addition to cuts, bruises and soft tissue damage. If a head injury has occurred, there also might be headaches, dizziness, blurred vision and neurological issues (Zhiyong, 2003).

Rollover crashes are also a type of impact accident. Most rollovers occur when a vehicle runs off a road and turns over on it sides or continues to flip over once. Rollover collisions might involve one vehicle or more. They are very serious crashes that result in a high number of accidents. For most cars, the chance of a rollover in an accident is less than 10%. There are some vehicles such as the Suzuki swift, which due to their high centre of gravity, are more prone to rollover. The statistics show that approximately 60% of fatalities in sport utility vehicles and 40% of fatalities in pickups were involved in rollovers. The rate for passengers' cars is 22% while it is 30% in minivans. Injuries in a rollover accident can be quite serious. It is believed that the best way to prevent or limit rollover injuries is to use the seat belt and avoid aggressive or erratic driving (WHO, 2003).

THEORETICAL FRAMEWORK

In recent years, concrete and effective work has been developed between different researchers with a view to finding the most significant factors among the traffic offences. The "SWEEDEN Traffic Surveillance" carried out a data prediction model for the processing of data analysis on road accidents to determine the factors that led to them. Also, the scientific research in the leading countries of the world in the area of road traffic offences has carried out a number of researches on road accident (Zhiyong, 2003).

Between 1960 and 1965, SHELL Petroleum Development Company (Nigeria) Limited, a subsidiary of the National Petroleum Development ran a series of program to ensure safety in Nigeria highways. This is followed by the introduction of the "Army Safety Week" which ran for a week in 1972, though the program achieved good result in the army and seemed to focus on the general public as an awareness campaign in 1974 (Setright, 2004).

The OYO state government in 1997 established the "OYO State Road Safety Corps" and its mandate were to carry out road safety operation along the Federal, State and Local government roads in the state. The evaluation of the effectiveness of the corps reveals that the number of road accident slightly reduced in the state for the period of 1978 to 1981of its operation. It was later banned by the Federal government from operating on the Federal roads in the state. After the demise of the OYO State Road Safety Corps, the National Road Safety Commission (NRSC) was constituted to be more effective with base at Federal Ministry of Work and Housing. In the effort of the government to stem the tide of accident and its related tragic consequences, Federal Road Safety Commission was established in 1988 by Decree 45 as amended in 1992 by Decree 35 (FRSC, 1995)

CONVENTIONAL HYPOTHESES SET

Suppose μ_i, $i = 1,2,...,k$ represents the mean of the traffic offence i, it may be of interest to investigate the prior believe that the mean of the k offences are not only different but also ordered in some sorts. Therefore, the interesting hypothesis of homogeneity of the form:

$H_0: \mu_1 = \mu_2 = ... = \mu_k = \mu$ against ordered alternative $H_1: \mu_1 < \mu_2 < ... < \mu_k$ may be derived.

Although we may have the probability of a type I error fixed at $\alpha = 0.05$ for each individual test, the probability of falsely rejecting at least one of those tests is larger than 0.05. in other words, the combined probability of $\binom{k}{2}$ hypothesis would be larger than the value 0.05 set for each individual test. However, what is desirable is a single test to perform the hypotheses set. This test procedure having a specified type I error rate of α should be powerful to determine whether the differences among the offences means are larger enough to imply that the corresponding offences means are different. Based on the assumption of normality for all the k offences with common variance σ^2, we compute the quality

$$s_w^2 = \frac{\sum_{i=1}^{k}\left(n_i - 1)s_i^2\right)}{\sum_{i=1}^{k}(n_i - 1)} \qquad 1.1a$$

$$s_w^2 = \frac{\sum_{i=1}^{k}\left(n_i - 1)s_i^2\right)}{n - k} \qquad 1.1b$$

where

n_i is the number of sample observations selected from population (offence) i

n is the total sample size taken from all the k offences.

Equation (1.1b) could be written as

$$s_p^2 = \frac{(n_1 - 1)s_1 + (n_2 - 1)s_2^2}{n_1 + n_2 - 2} \qquad 1.2$$

which is the estimate of the common variance for the two populations for the t-test statistic (Thompson, 1992).

If the null hypothesis $\mu_1 = \mu_2 = ... = \mu_k = \mu$ is true, then the k populations (offences) are identical with mean μ and variance σ^2. Thus, drawing single samples from the k offences is then equivalent to drawing k different samples from the same population. Suppose $n_i = m \; \forall \; i = 1,2,3,...,k$, then the sample distribution of the means $\overline{Y}_i$ based on m measurements will have the same mean μ_i and common variance $\frac{\sigma^2}{m}$.

Now, we have to consider the $\overline{Y}_i$'s as a sample of size k having m observations each. There, we estimate the variance of the distribution of sample means $\frac{\sigma^2}{m}$ by

$$sample\,variance = \frac{\sum_{i=1}^{k} \overline{Y}_i^{\,2} - \frac{\left(\sum_{i=1}^{k} \overline{Y}_i\right)^2}{k}}{k-1} \qquad 1.3$$

Since this quantity estimates $\frac{\sigma^2}{m}$, hence the quantity $s_B^2 = m \; X \; sample\,variance$ equally gives the estimate of the common variance σ^2 and it measures the variability between or among the k offences means.

If $n_i \neq m$ for at least one $i = 1,2,...,k$ then s_B^2 becomes

$$s_B^2 = \frac{\sum_{i=1}^{k} n_i \left(\overline{Y}_i - \overline{Y}\right)^2}{k-1} \qquad 1.4$$

Thus, for $n = m \; \forall \; i$, we have

$$s_B^2 = \frac{m \sum_{i=1}^{k} \left(\overline{Y}_i - \overline{Y}\right)^2}{k-1} \qquad 1.5$$

Under the null hypothesis that all the k offences means are identical, we have two estimates of σ^2 namely s_w^2 and s_B^2. Then, the ratio $\frac{s_B^2}{s_w^2}$ is a suitable test statistic to test the hypothesis that $\mu_1 = \mu_2 = ... = \mu_k$ (Montgomery, 1991a).

Consequently, $F = \frac{s_B^2}{s_w^2}$ follows an $F-$distribution with the first degree of freedom (df_1) = k-1 and the second degree of freedom (df_2) = n-k.

In testing the hypothesis of homogeneity $H_0 : \mu_1 = \mu_2 = ... = \mu_k$ against the non-directional alternative, H_0 is rejected if $F = \frac{s_B^2}{s_w^2}$ exceeds the tabulated value of F for a specified type I error α, with df_1 = k-1 and df_2 = n-k.

Test Statistic for the Directional Alternative

Here we discuss adaptation of hypothesis testing procedures which are constructed for directional alternative. An attempt is also made at examining some properties such a proposed system has. Suppose $Y_1, Y_2, ..., Y_k$ represents a set of independently and normally distributed random variables with means $\mu_1, \mu_2, ..., \mu_k$ and common variance σ^2 but μ_i's and σ^2 are unknown (Paul, 1995).

Now, consider the test hypothesis of homogeneity of the form:
$H_0: \mu_1 = \mu_2 = ... = \mu_k = \mu$ against the ordered alternative $H_1: \mu_1 < \mu_2 < ... < \mu_k$.
This hypothesis could be written as:
$H_0: \mu_2 - \mu_1 = \mu_3 - \mu_2 = ... = \mu_k - \mu_{k-1} = 0$ against
$H_1: 0 < \mu_2 - \mu_1 < \mu_3 - \mu_2 < ... < \mu_k - \mu_{k-1}$
Let $\delta_i = \mu_i - \mu_{i-1}, 2 \le i \le k$.
Then $\mu_i - \mu_{i-1} \succ 0$ if and only if $\delta_i \succ 0$.
Hence, the above test problem becomes:
$H_0: \delta_i = 0$ against $H_1: \min \delta_i \succ 0$.
The unbiased estimator of δ_i is given by

$$\hat{\delta}_i = \overline{Y_i} - \overline{Y_{i-1}} \qquad 1.6$$

Then $\hat{\delta}_i \sim N\left(\delta_i, V(\hat{\delta}_i)\right)$

and
$$V(\hat{\delta}_i) = V(\overline{Y_i} - \overline{Y_{i-1}}) = V(\overline{Y}) + V(\overline{Y}_{i-1}) = \frac{\sigma^2}{n_i} + \frac{\sigma^2}{n_{i-1}}$$

Thus,

$$V(\hat{\delta}_i) = \left(\frac{n_i + n_{i-1}}{n_i n_{i-1}}\right)\sigma^2 \qquad 1.7$$

Now, consider the quantity m_{i-1}, such that

$$m_{i-1} = \sqrt{\frac{n_i n_{i-1}}{n_i + n_{i-1}}}$$

And let
$$\hat{\gamma}_{i-1} = m_{i-1}\hat{\delta}_i = m_{i-1}\left(\overline{Y_i} - \overline{Y_{i-1}}\right)$$

Then $\hat{\gamma}_{i-1} \sim N(\gamma_{i-1}, \sigma^2)$ 1.8
Where $\gamma_{i-1} = m_{i-1}(\mu_i - \mu_{i-1})$
Therefore, the hypothesis set can be written in terms of γ_{i-1} as
$H_o: \gamma_{i-1} = 0$ against $H_1: \min \gamma_{i-1} > 0 \quad \forall i = 1,2,\ldots,k$

Now, let
$$s_i^2 = \frac{1}{n_{i-1}}\sum_{j=1}^{n_i}\left(Y_{ij} - \overline{Y}_i\right)^2$$

And
$$s^2 = \frac{1}{n-k}\sum_{i=1}^{k}\sum_{j=1}^{n_i}\left(Y_{ij} - \overline{Y}_i\right)^2$$

Then,
$$s^2 = \frac{1}{n-k}\sum_{i=1}^{k}(n_i - 1)s_i^2 \qquad 1.9$$

Where;
s_i^2 is the sample variance for variate Y_i and s^2 is the combined sample variance for all the k variates.

If we assign $\min \dfrac{m_{i-1}\left(\overline{Y}_i - \overline{Y}_{i-1}\right)}{s}$ to T and compare with $t_{k,n,\alpha}$, then

$T = \min \frac{m_{i-1}\left(\overline{Y}_i - \overline{Y}_{i-1}\right)}{s} > t_{k,n,\alpha}$ would implying rejecting H_0.

Where $m_{i-1} = \sqrt{\frac{n_i n_{i-1}}{n_i + n_{i-1}}}$

For equal sample sizes $n_i = m \quad \forall \quad i$, then test statistics T becomes

$$T = \min \frac{\sqrt{m}\left(\overline{Y}_i - \overline{Y}_{i-1}\right)}{s} \qquad 1.10$$

which has the t – distribution with $n-k$ degree of freedom.

If H_0 is rejected, it shows that the k offences' means follow the form of the ordered alternative. But if H_0 is not rejected, this is not an evidence that all the k offences' means are homogeneous. We can only say that their homogeneity does not follow an ordered form in some sort, but actually there might be significant differences between some pairs of means (Montgomery, 1991a).

DATA PRESENTATION AND ANALYSIS

We present the procedure for using the proposed test statistic. The data used in this study were extracted from Niger State Statistical Year Books.

Table 1.1: Presentation of Data used

S/N	Year	Reckless Driving	Over Loading	Mechanical Faults	Drug Abuse
1	1997	101	38	92	45
2	1998	81	57	53	70
3	1999	99	12	10	92
4	2000	117	82	57	53
5	2001	104	72	54	50
6	2002	158	70	37	134
7	2003	178	78	69	115
8	2004	256	46	70	80
9	2006	150	17	54	54
10	2007	40	28	34	28
Mean		128.4	50	53	72.1

Source: Niger State Statistical Year Books

If μ_i represents the mean for offence $i \; \forall \quad i = 1,2,3,4$ stands for reckless driving, over loading, mechanical faults and drug abuse respectively, then the desired hypothesis is

$H_o : \mu_2 = \mu_3 = \mu_1 = \mu_4$ against $H_o : \mu_2 < \mu_3 < \mu_1 < \mu_4$

By this, we assume that Y_{ij} represents the number of times the offences is committed in each offence i for year j, $i = 1,2,3,4$ and $j = 1997, 1998, \ldots, 2006$.

Then $Y_{ij} \sim N\left(\mu_{ij}, \sigma^2\right)$.

COMPUTATION

From the data in table 1.1, the following summary statistics were obtained.

Reckless Driving: $\overline{Y}_1 = 128.4$, $S_1^2 = 3609.6$, $n_1 = 10$

Over Loading: $\overline{Y}_2 = 50$, $S_2^2 = 657.6$, $n_2 = 10$

Mechanical Faults: $\overline{Y}_3 = 53$, $S_3^2 = 505.6$, $n_3 = 10$

Drug Abuse: $\overline{Y}_4 = 152.1$, $S_4^2 = 1110.5$, $n_4 = 10$

Arranging the sample means in ascending order of magnitude with $\overline{X}_1, \overline{X}_2, \overline{X}_3$ and $\overline{X}_4$ representing the order of arrangement, we have:

$\overline{Y}_2(\overline{X}_1)$ $\overline{Y}_3(\overline{X}_2)$ $\overline{Y}_1(\overline{X}_3)$ $\overline{Y}_4(\overline{X}_4)$

50 53 128.4 152.1

Then, consider the differences given below:

$\overline{X}_2 - \overline{X}_1 = 53 - 50 = 3$

$\overline{X}_3 - \overline{X}_2 = 128.4 - 53 = 75.4$

$\overline{X}_4 - \overline{X}_3 = 152.1 - 128.4 = 23.7$

$\min\left(\overline{X}_i - \overline{X}_{i-1}\right) = \overline{X}_2 - \overline{X}_1 = 3$

with $n_i = 10, \quad n_{i-1} = 10, \quad k = 4$

$$n = \sum_{i=1}^{4} n_i = 40$$

Then $S = 1470.825$ and $T = 0.1749$

At $\alpha = 0.05$ significant level, we have $t_{n-k,1-\alpha} = t_{36,0.95} = 1.6892$

Since $T < t_{36,0.95}$, we therefore do not reject H_0 at $\alpha = 0.05$ and conclude that the means of all the offences do not follow the expected ordered form.

CONCLUSION AND RECOMMENDATIONS

This study is concerned with the different types of offences on highways in Niger state. To determine the most significant among these offences, a hypothesis was postulated and tested using directional hypothesis. It was found that the offences do not significantly different from one another. Based on the conclusion, it is recommended that Federal Road Safety Commission (FRSC) should look into all these offences and organize series of seminars for the drivers to enlighten them so that the rate of accident on the highway could be reduced.

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