

RELATIONSHIP of PREVENTABLE to NONPREVENTABLE ACCIDENTS in the TRUCKING INDUSTRY

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IT is not too uncommon to hear a safety director state that all accidents are chargeable to the drivers or workers involved in the accident. If a distinction between chargeable and nonchargeable accidents exists, it is extremely fine. In many organizations penalty is based on such an analysis. Generally in the trucking industry, accidents are classified as preventable or nonpreventable. The preventable accident is one in which the driver of the vehicle is clearly responsible for the accident. Such accidents as grade collisions with trains, backing accidents, collision with a vehicle ahead, accidents while passing, may be classified as preventable, except where even in these instances the driver incurred the accident through no fault of his own. A nonpreventable accident is one in which the driver of the vehicle is not responsible for the accident. Such accidents as a collision while properly parked, mechanical failures, and so forth may be classified as nonpreventable.

Ordinarily, in determining the preventable and nonpreventable classification of an accident in the trucking industry, the judges (investigating officer, safety director, field supervisor, safety supervisor, etc.) ask the question: "Could the driver have done anything to have prevented the accident?" If the answer is yes and they can determine what he should have done and could have done to have avoided the accident, the accident is charged to him. However, if there is nothing he could have done to have avoided the accident, the accident is not charged to him.

PROBLEM

The question of the relationship between preventable and nonpreventable accidents is the major objective of this paper. The hypothesis may be stated somewhat as follows: Preventable and nonpreventable accidents are closely related to one another in both their causes and general characteristics.

In this paper an attempt is made to answer the question more from a statistical point of view than from a descriptive analysis of the accidents. Moreover, no attention is placed on the reliability of the accident classification whether it be a preventable or nonpreventable one. Problems of low reliability in this area are well known to research workers in this field. The assumption is that whatever classification is available it is still the best that can be used in these analyses.

SUBJECTS

In this study 100 over-the-road tractor-trailed drivers employed by the McLean Trucking Company in Winston-Salem, North Carolina were used.

All of these drivers were studied during their first 12 mo. of employment. The basis of analysis used was the number of preventable or nonpreventable accidents incurred by the drivers for any month of the employment period. Records indicate that each driver drives approximately 5,000 mi. per mo. No attempt was made to control route traveled or time of year employed. In fact, this sample of 100 drivers was taken from a total driving population of 215 drivers.

METHOD

The methods used in the analysis of the data involved the following:

1. Analysis of the distributions of preventable and nonpreventable accidents for the 1 to 3, 4 to 6, 1 to 6, 7 to 12 and 1 to 12 month periods of employment were made. These distributions were studied by comparison to Poisson distributions based on the same means as the actual distribution. The statistical tool of chi squared was used in these analyses. Also, the amount of variance greater than that anticipated by chance was studied.
2. Correlations were computed between two successive periods of employment for both preventable and non-preventable accidents. The comparisons made were between the 1 to 3 and 4 to 6 mo., and 1 to 6 and 7 to 12 mo. of employment. Chi-squared tests of independence were used to determine the significance level of the correlations for the preventable accidents only.
3. Relationships of certain personal and psychological traits of these drivers with the number of preventable and nonpreventable accidents were computed. The t tests between the number of accidents (preventable or nonpreventable) for the upper and lower 50 percent and upper and lower 25 percent of drivers for each variable were determined.
4. A graphic presentation of preventable and nonpreventable accidents for 91 drivers employed for at least 18 mo. was made.
5. The coefficient of correlation between preventable and nonpreventable accidents for the full 12 mo. of employment was computed.

ANALYSIS OF DATA

In Table 1 are given the frequencies, means, variances and chi squares for the preventable accidents for 1 to 3, 4 to 6, and 6 mo. of employment. Comparisons are made of the actual accident distributions with Poisson or chance expectancy. Through the use of chi squared, it can be seen that the probabilities are not high enough to indicate that anything but chance is in operation. The probability level is 0.44 for the 1 to 3 mo. period. For the 4 to 6 mo. period the probability level was 0.68. For the full 6 mo. of employment the probability level is 0.50.

In Table 2 are given the frequencies, means, variances and chi squares for the preventable accidents for 1 to 6, 7 to 12 mo., and 12 mo. of employment. Probability levels here also indicate chance expectancy: 0.50 for 1 to 6 mo., 0.44 for 7 to 12 mo., and 0.64 for the 12-mo. period of employment.

TABLE 1

TABLE OF FREQUENCIES, MEANS, VARIANCES AND CHI SQUARES
OF PREVENTABLE ACCIDENTS FOR 100 COMPANY-TRAINED TRUCK DRIVERS
FOR 1 TO 3 MO., 4 TO 6 MO. AND 6 MO. OF EMPLOYMENT

No. of Preventable Accidents	1-3 Months	4-6 Months	6 Months
0	77	73	55
1	19	24	34
2	4	3	9
3	0	0	2
4	0	0	0
N	100	100	100
Means	.2700	.3000	.5800
Variances	.2771	.2700	.5436
Poisson "Fit"	χ^2	.644	1.410
	d.f.	1	2
	P	.44	.68
$\frac{\text{Variance-Mean}}{\text{Variance}} \times 100$	2.6	—	—

TABLE 2

TABLE OF FREQUENCIES, MEANS, VARIANCES AND CHI SQUARES
OF PREVENTABLE ACCIDENTS FOR 100 COMPANY-TRAINED TRUCK DRIVERS
FOR 1 TO 6, 7 TO 12, AND 12 MO. OF EMPLOYMENT

No. of Preventable Accidents	1-6 Months	7-12 Months	12 Months
0	55	79	45
1	34	16	31
2	9	4	19
3	2	0	3
4	0	1	2
N	100	100	100
Means	.5800	.2800	.8600
Variances	.5436	.4016	.9204
Poisson "Fit"	χ^2	1.410	1.718
	d.f.	2	3
	P	.50	.44
$\frac{\text{Variance-Mean}}{\text{Variance}} \times 100$	—	30.3	6.6

In Table 3 are given the frequencies, means, variances and chi squares for the nonpreventable accidents for 1 to 3 mo., 4 to 6 mo., and 6 mo. of employment. Probabilities here are even higher than for similar periods in the preventable accidents: 0.88, 0.90, and 0.94, respectively.

TABLE 3

TABLE OF FREQUENCIES, MEANS, VARIANCES, AND CHI SQUARES
OF NONPREVENTABLE ACCIDENTS FOR 100 COMPANY TRAINED TRUCK DRIVERS
FOR 1 TO 3, 4 TO 6, AND 6 MO. OF EMPLOYMENT

No. of Nonpreventable Accidents	1-3 Months	4-6 Months	6 Months
0	76	80	62
1	21	18	28
2	3	2	8
3	0	0	1
4	0	0	1
N	100	100	100
Means	.2700	.2200	.5100
Variances	.2971	.2116	.5899
Poisson χ^2	.0233	.0109	.3885
"Fit" d.f.	1	1	3
P	.88	.90	.94
$\frac{\text{Variance-Mean}}{\text{Variance}} \times 100$	9.0	---	13.5

In Table 4 are given the similar data for nonpreventable accidents for 1 to 6, 7 to 12, and 12 mo. of employment. Probabilities, here, are 0.94, 0.96, and 0.45, respectively.

TABLE 4

TABLE OF FREQUENCIES, MEANS, VARIANCES AND CHI SQUARES
OF NONPREVENTABLE ACCIDENTS FOR 100 COMPANY-TRAINED TRUCK DRIVERS
FOR 1 TO 6, 7 TO 12, AND 12 MO. OF EMPLOYMENT

No. of Nonpreventable Accidents	1-6 Months	7-12 Months	12 Months
0	62	75	44
1	28	21	38
2	8	3	12
3	1	0	4
4	1	1	2
N	100	100	100
Means	.5100	.3100	.8200
Variances	.5899	.3939	.8676
Poisson χ^2	.3885	.2336	2.5450
"Fit" d.f.	3	3	3
P	.94	.96	.45
$\frac{\text{Variance-Mean}}{\text{Variance}} \times 100$	13.5	21.3	5.49

This phase of the analysis indicates that both types of accidents tend to behave like chance distributions of the Poisson variety and that closer

chance expectancy is observed in the nonpreventable accident classifications. One should state that some question has been raised as to the applicability of chi squared as a fine-enough tool for making these distinctions.

In Tables 5, 6, 7, and 8 are shown the bivariate distributions for both the preventable and nonpreventable accidents.

TABLE 5

BIVARIATE DISTRIBUTION OF PREVENTABLE ACCIDENTS FOR 100 COMPANY-TRAINED TRUCK DRIVERS FOR 1 TO 3 AND 4 TO 6 MO. OF EMPLOYMENT

Period I (1-3 Months)	Period 2 (4-6 Months)					Total
	0	1	2	3	4	
0	56	18	3	---	---	77
1	15	4	---	---	---	19
2	2	2	---	---	---	4
3	---	---	---	---	---	0
4	---	---	---	---	---	0
Total	73	24	3	0	0	100

$r = .004$

X^2 test of independence = .270

d.f. = 4 p = 99

TABLE 6

BIVARIATE DISTRIBUTION OF PREVENTABLE ACCIDENTS FOR 100 COMPANY-TRAINED TRUCK DRIVERS FOR 1 TO 6 AND 7 TO 12 MO. OF EMPLOYMENT

Period I (1-6 Months)	Period 2 (7-12 Months)					Total
	0	1	2	3	4	
0	45	6	3	---	1	55
1	25	8	1	---	---	34
2	8	1	---	---	---	9
3	1	1	---	---	---	2
4	---	---	---	---	---	0
Total	79	16	4	---	1	100

$r = .027$

X^2 test of independence = 4.370 p = .37 d.f. = 4

In the preventable classification for the period 1 to 3 with 4 to 6 mo., r was 0.004 and lacks statistical significance. This was also true in the relationship noted for the 1-to-6-mo. with the 7-to-12 mo. period with a coefficient of correlation of 0.027. The chi-squared tests of independence indicated that neither correlation was significant or showed relationship.

In the nonpreventable classification, an r of 0.19 was obtained for the 1-to-3 mo. with the 4-to-6 mo. period and an r of -0.42 for the 1-to-6-mo. with the 7-to-12-mo. period.

TABLE 7

BIVARIATE DISTRIBUTION OF NONPREVENTABLE ACCIDENTS FOR 100
COMPANY-TRAINED TRUCK DRIVERS FOR 1 TO 3
AND 4 TO 6 MO. OF EMPLOYMENT

Period 1 (1-3 Months)	Period 2 (4-6 Months)					Total
	0	1	2	3	4	
0	62	13	1	—	—	76
1	15	5	1	—	—	21
2	2	—	1	—	—	3
3	—	—	—	—	—	
4	—	—	—	—	—	
Total	79	18	3			100

$$r = .19$$

TABLE 8

BIVARIATE DISTRIBUTION OF NONPREVENTABLE ACCIDENTS FOR 100
COMPANY-TRAINED TRUCK DRIVERS FOR 1 TO 6
AND 7 TO 12 MO. OF EMPLOYMENT

Period 1 (1-6 Months)	Period 2 (7-12 Months)					Total
	0	1	2	3	4	
0	44	15	2	—	1	62
1	22	5	1	—	—	28
2	6	2	—	—	—	8
3	1	—	—	—	—	1
4	1	—	—	—	—	1
Total	74	22	3	0	1	100

$$r = -.42$$

With the exception of the last coefficient of correlation one must conclude that there is lack of consistency in the number of either preventable or nonpreventable accidents incurred by the drivers for any two successive periods of time. At this point, no suitable explanation has been disclosed for the high negative correlation for the nonpreventable accidents when the 1-to-6-mo. period was related to the 7-to-12-mo. period other than the fact that this high correlation probably occurred by chance.

In Tables 9 and 10 are given the t values between the number of accidents (preventable and nonpreventable) for the upper and lower 50 percent and upper and lower 25 percent of drivers for each variable, the personal or psychological data. For the preventable accidents two factors appear to distinguish low accident drivers at a reasonable statistically significant level, these being dependency and emotional stability. Age and mechanical comprehension appear to be also important. For the nonpreventable accidents, no one variable showed differences to be statistically significant. Self-sufficiency, a trait of personality measured by the Bernreuter Personality Inventory showed a t value of 1.32 significant at less than the 10-

TABLE 9

TABLE OF MEANS AND STANDARD DEVIATIONS FOR NUMBER OF PREVENTABLE ACCIDENTS FOR THE LOWER AND UPPER 50 PERCENT AND LOWER AND UPPER 25 PERCENT OF THE COMPANY-TRAINED DRIVERS ON EACH PERSONAL FACTOR AND PSYCHOLOGICAL TEST AND RELATIONSHIPS EXPRESSED BY t RATIOS

Variable	Lower 50%		Upper 50%		t	Lower 25%		Upper 25%		t
	Mean	σ	Mean	σ		Mean	σ	Mean	σ	
Age	.0580	.079	.0760	.076	1.16	.0500	.075	.0592	.060	.48
Education	.0630	.070	.0726	.084	.62	.0728	.072	.0992	.091	1.14
Dependents	.0830	.090	.0526	.059	2.00**	.0764	.091	.0460	.058	1.41
Experience	.0660	.076	.0680	.079	.13	.0624	.079	.0896	.088	1.15
Wonderlic (Intelligence)	.0646	.079	.0694	.077	.31	.0628	.072	.0660	.062	.17
Bennett Mech. Comprehension	.0730	.088	.0576	.061	1.02	.0596	.065	.0656	.057	.85
Emotional Stability	.0528	.072	.0812	.081	1.84*	.0528	.062	.0656	.057	.77
Self-Sufficiency	.0662	.075	.0678	.081	.10	.0620	.075	.0564	.066	.28
Dominance	.0578	.077	.0728	.077	.97	.0660	.071	.0860	.084	.91

***Significant at the 1% level of confidence

** Significant at the 5% level of confidence

* Significant at the 10% level of confidence

TABLE 10

TABLE OF MEANS AND STANDARD DEVIATIONS FOR NUMBER OF NONPREVENTABLE ACCIDENTS
FOR THE LOWER AND UPPER 50 PERCENT AND LOWER AND UPPER 25 PERCENT OF THE COMPANY-TRAINED DRIVERS ON
EACH PERSONAL FACTOR AND PSYCHOLOGICAL TEST AND RELATIONSHIPS EXPRESSED BY *t* RATIOS

Variable	Lower 50%		Upper 50%		<i>t</i>	Lower 25%		Upper 25%		<i>t</i>
	Mean	σ	Mean	σ		Mean	σ	Mean	σ	
Age	.0726	.078	.0588	.076	.91	.0560	.070	.0784	.089	.98
Education	.0656	.076	.0692	.079	.23	.0684	.080	.0592	.069	.44
Dependents	.0560	.070	.0772	.084	1.38	.0728	.073	.0888	.097	.67
Experience	.0658	.078	.0690	.077	.21	.0692	.070	.0520	.052	1.00
Wonderlic Intelligence	.0608	.074	.0724	.081	.75	.0684	.073	.0792	.077	.51
Bennett Mech. Comprehension	.0674	.086	.0658	.069	.10	.0488	.074	.0456	.053	.18
Emotional Stability	.0640	.060	.0490	.077	1.09	.0960	.066	.0524	.091	1.96*
Self-Sufficiency	.0774	.084	.0574	.069	1.32	.0756	.091	.0556	.077	.84
Dominance	.0626	.076	.0722	.079	.62	.0656	.078	.0588	.065	.34

***Significant at the 1% level of confidence

** Significant at the 5% level of confidence

* Significant at the 10% level of confidence

percent level and dependency with a t value of 1.38 which is also significant at less than the 10-percent level.

This analysis appears to indicate that more of the personal or human element is involved in the preventable type of accident than in the non-preventable type.

In Figure 1 are shown side by side the preventable and nonpreventable accidents for 91 drivers employed for at least 18 mo. These curves show that preventable accidents appear to follow a curvilinear relationship—rapid acceleration with gradual deceleration, particularly after the twelfth month of employment whereas the nonpreventable accidents appear to behave in a more linear fashion. In other words, the number of nonpreventable accidents a driver will have is more dependent on the length of the driving period whereas the number of preventable accidents tends to fall off after a certain period of employment.

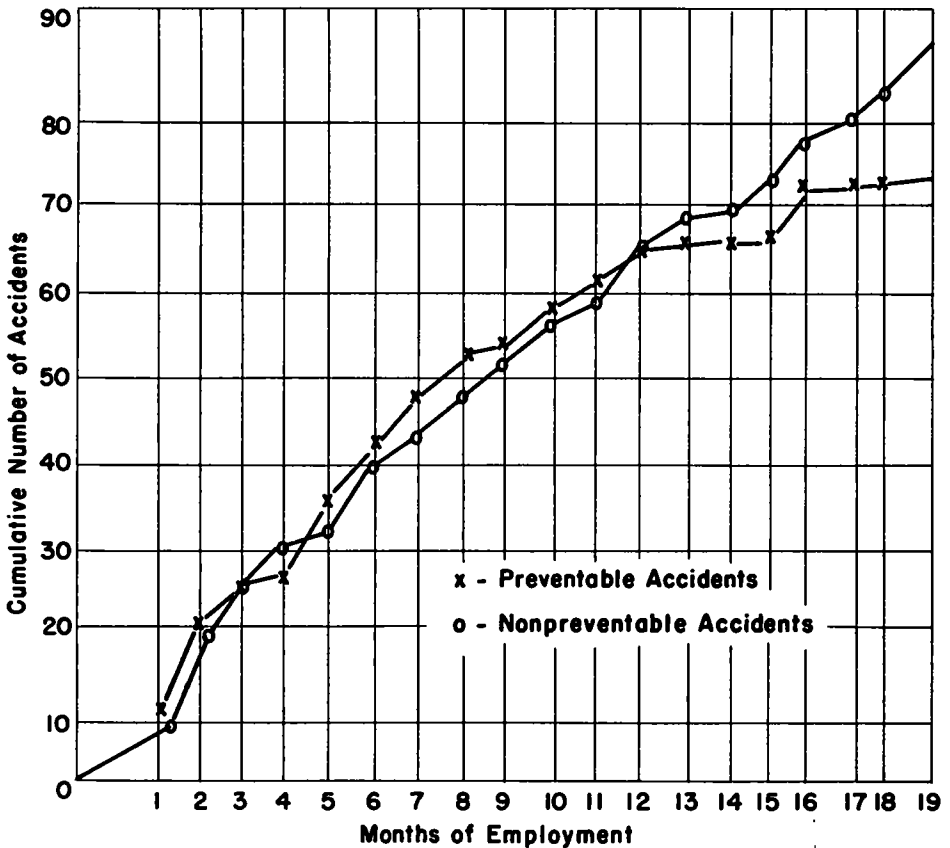


Figure 1. Preventable and nonpreventable accidents for 91 drivers employed for at least 18 mo.

Finally, a coefficient of correlation was computed between the number of preventable and nonpreventable accidents for the full 12 mo. of employment. This correlation was minus 0.12 and was not statistically signifi-

cant. This fact means that the number of preventable accidents incurred by drivers is not related to the number of nonpreventable accidents incurred by these same drivers for a given period of time.

CONCLUSIONS

1. Nonpreventable accidents tend to occur over a given period of time more in line with chance expectancy than preventable accidents.
2. Personal and psychological factors appear to be more related to preventable accidents than to nonpreventable accidents.
3. Both the preventable and nonpreventable accidents tend to have notoriously low reliabilities or consistency of occurrence between two successive periods of time.
4. Zero relationships exist between the number of preventable and nonpreventable accidents for a group of drivers for a given period of time.

In summary, this paper shows that the distinction between preventable and nonpreventable accidents is not clear cut.

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