Conference Presentation.

Crane operator training, is the current system the way to go?

Name: Ian Douglas. Nat Dip OHS, BHlth Sc OHS (1st class Hons), MSIA, MGKIHS.
Position; Currently studying for PhD in OHS through an Edith Cowan University postgraduate research scholarship (Three year tenure).

Introduction.

During 2003 I evaluated crane operator training methods in Western Australia as part of my honours studies. The purpose of the research was to compare the accident and incident rates and the year of certification of crane operators in WA. The survey was carried out with operators from within the general hire, mining, civil and CBD construction industries.

The method of crane operator training in Australia changed 10 years ago (in 1994) from the old system of logged hours to the new competency based system. The new system is called the "National Occupational Health & Safety Certification Standards for Users & Operators of Industrial Equipment" [NOHSC: 1106 (2001)]. Appendix B of the standard applies to crane and hoist operations.

This research study was conducted to establish if there was a relationship between the method of training provided to an operator and the number of accidents or incidents they were involved in. A series of crane accidents that occurred in the first three months of 2002 and which prompted the Western Australian state government to establish the "Crane Safety Standards Working Party" who tabled their report to parliament on the 5th August 2002.

This study was a collaborative effort and I would like to thank the following for their assistance in not only supplying data, but also for help in the distribution and collection of the survey questionnaires used for data collection. WorkSafe WA, Department of Industry and Resources WA, Construction Forestry Mining & Energy Union WA, Australian Manufacturing Workers Union WA, Mission Employment and Ms T. Shaw (my stats coach).

Methodology.

Although several attempts were made to establish the study on a tripartite basis, the employer groups chose not to participate. This reluctance to participate virtually eliminated the opportunity to be able to access new trainees for the purpose of training evaluation or to evaluate the employers' attitude to the current system of training.

The study was a cross-sectional descriptive analysis of the variables, year of certification, accident and incident rates. A questionnaire was developed and pilot tested for validity and reliability before being used in the study. After pilot testing the necessary alterations were made to the questionnaire and the new version was again pilot tested to confirm validity and reliability.

Once the questionnaires had been validated they were delivered to different groups for distribution and completion. The methods of distribution included, 1. Union mailing lists. 2. Union organisers. 3. Employment assistance

providers. 4. Labour hire companies. 5. Crane hire yards. 6. Mine sites. All questionnaires were attached to a stamped addressed envelope for return to the university. The data collection took place from the 20th February 2003 through until the 30th May 2003. A total of 125 completed questionnaires were returned to the university during this period. There were 123 male and 2 female respondents.

Apart from the data which was generated through the crane operators questionnaire there was also accident and incident information collected from the two government departments who were participating in the research. Although the quality of the mining data collected was excellent the non-provision of certain information created its own limitations for the research.

For example it was not possible to quantify the exposure rates of each group, which in turn made it impossible to establish either the incidence rates (IR) or the relative risks (RR). The actual number of accidents occurring was difficult to establish with the primary cause of this shortfall being the inadequate legislative reporting and recording requirements for crane accidents which existed at the time. This has since been altered and improved.

Results.

By using the data from the questionnaires it was established that out of the total number of accidents reported by the operators 44% were reported directly to the owner/employer, 4% were reported to WorkSafe and over 31% were not reported to anyone.

Whenever the data would allow (for dichotomous responses) the "Yates Continuity Correction" figure was used from the chi-square tests in order to minimise the chances of making a "TYPE 1" error. A "TYPE 1 error is when, as a researcher you incorrectly reject the *Null Hypothesis*, when in fact the researcher should have accepted it.

The demographic data of the operators which was generated through the survey questionnaire indicated that there were a total of 94 (75.2%) operators who gained their certificates prior to 1994 with the other 31 (24.8%) being certificated post 1994. Sixty-six (52.8%) of the respondents admitted being involved in a crane accident at some time during their working careers compared to 59 (47.2%) who indicated that they had never been involved in an accident. Data would indicate that this group of workers would work an average of 10 hours per day.

On-the-job training was the primary source of provision accounting for 90 (72%) respondents with a further 31 (24.8%) having only classroom based training and the remaining 4 (3.2%) being trained with a combination of both classroom and on-the-job methods. Table 1 shows a summation of the most preferred method of training as measured through the crane operator's responses in the questionnaire.

By studying the data in Table 2 the average time spent by the respondents operating cranes in months was established. The average time spent operating cranes for the respondents is 156.6 months (13.05 years) with a standard deviation of 114.36 months (9.53 years). The median measure is 144 months (12 years). The range of the data was from 0 - 420 months.

Table 1. Crane operators preferred method of training.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	classroom	2	1.6	1.6	1.6
	on-the-job	81	64.8	64.8	66.4
	a combination of both	42	33.6	33.6	100.0
	Total	125	100.0	100.0	

Table 2. Descriptive statistics for operators overall time spent operating cranes.

			Statistic	Std. Error
Total time spent operating cranes (mnths)	Mean		156.60	10.27
	95% Confidence Interval for Mean	Lower Bound	136.28	
		Upper Bound	176.93	
	5% Trimmed Mean		152.39	
	Median		144.00	
	Variance		13079.168	
	Std. Deviation		114.36	
	Minimum		0	
	Maximum		420	
	Range		420	
	Interquartile Range		198.00	
	Skewness		.455	.217
	Kurtosis		-.635	.431

A Chi-square test for independence was conducted between the variables year of certification and ever being involved in an accident. The results of the test from Table 4 can be summarised as χ^2 (1, N = 125) = 38.05, P=.000. Table 3 shows a cross tabulation between the variables of ever being involved in a crane accident and the year of certification.

Table 5 shows the cross tabulation between the year of certification and ever being involved in a crane incident. The results of the Chi-square test conducted on the data may be found in Table 6 and can be summarised as χ^2(1, N = 124) = 43.37, P = .000.

Table 3. Ever been involved in a crane accident * Year of certification.

			ever been involved in an accident		
			yes	no	Total
year first gained certificate	prior to 1994	Count	65	29	94
		Expected Count	49.6	44.4	94.0
		% within year first gained certificate	69.1%	30.9%	100%
		% within ever been involved in an accident	98.5%	49.2%	75.2%
		% of Total	52.0%	23.2%	75.2%
	post 1994	Count	1	30	31
		Expected Count	16.4	14.6	31.0
		% within year first gained certificate	3.2%	96.8%	100%
		% within ever been involved in an accident	1.5%	50.8%	24.8%
		% of Total	.8%	24.0%	24.8%
Total		Count	66	59	125
		Expected Count	66.0	59.0	125.0
		% within year first gained certificate	52.8%	47.2%	100%
		% within ever been involved in an accident	100%	100%	100%
		% of Total	52.8%	47.2%	100%

Table 4. **Chi-square tests ever been involved in a crane accident * year of certification**.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	40.65[b]	1	.000		
Continuity Correction[a]	38.05	1	.000		
Likelihood Ratio	47.89	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	40.33	1	.000		
N of Valid Cases	125				

a. Computed only for a 2x2 table

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 14.63.

Table 5. Cross tabulation between year of certification * ever been involved in a crane incident.

			year first gained certificate		
			prior to 1994	post 1994	Total
ever been involved in an incident	yes	Count	84	9	93
		Expected Count	69.8	23.3	93.0
		% within ever been involved in an incident	90.3%	9.7%	100%
		% within year first gained certificate	90.3%	29.0%	75.0%
	no	Count	9	22	31
		Expected Count	23.3	7.8	31.0
		% within ever been involved in an incident	29.0%	71.0%	100%
		% within year first gained certificate	9.7%	71.0%	25.0%
Total		Count	93	31	124
		Expected Count	93.0	31.0	124.0
		% within ever been involved in an incident	75.0%	25.0%	100%
		% within year first gained certificate	100.0%	100.0%	100%

Table 6. Results of chi-square tests between the variables year of certification and ever been involved in a crane incident.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	46.58[b]	1	.000		
Continuity Correction[a]	43.37	1	.000		
Likelihood Ratio	42.97	1	.000		
Fisher's Exact Test				.000	.000
Linear-by-Linear Association	46.20	1	.000		
N of Valid Cases	124				

a. Computed only for a 2x2 table

b. 0 cells (.0%) have expected count less than 5. The minimum expected count is 7.75.

A Chi-square test for independence was conducted on the cross tabulation data found in Table 7 to establish if there was an association between the year of certification and the non-reporting of crane incidents. The results are to be found in Table 8 can be summarised as χ^2 (2, N = 115) = 31.1, P =.000.

Table 7. Cross tabulation of not reporting crane incidents * year of certification.

			year first gained certificate		
			prior to 1994	post 1994	Total
Not reported incidents	None	Count	12	12	24
		Expected Count	19.6	4.4	24.0
		% within Not reported incidents	50.0%	50.0%	100.0%
		% within year first gained certificate	12.8%	57.1%	20.9%
	1-5 times	Count	18	8	26
		Expected Count	21.3	4.7	26.0
		% within Not reported incidents	69.2%	30.8%	100.0%
		% within year first gained certificate	19.1%	38.1%	22.6%
	6+ times	Count	64	1	65
		Expected Count	53.1	11.9	65.0
		% within Not reported incidents	98.5%	1.5%	100.0%
		% within year first gained certificate	68.1%	4.8%	56.5%
Total		Count	94	21	115
		Expected Count	94.0	21.0	115.0
		% within Not reported incidents	81.7%	18.3%	100.0%
		% within year first gained certificate	100.0%	100.0%	100.0%

A chi-square test for independence was conducted on the variables year of certification and the reporting of accidents using a newly created variable “was accident reported” (WASREPC). The results of the cross tabulation table from the test have not been included as they appeared to violate the assumption of independence for Chi-square tests with all of the cells having an expected count of less than five at 0.12 per cell. This can be seen from the Chi-square test result table, which appears as Table 9.

Table 8. Chi-square test results for not reporting crane incidents * year of certification.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.10[a]	2	.000
Likelihood Ratio	33.62	2	.000
Linear-by-Linear Association	30.52	1	.000
N of Valid Cases	115		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 4.38.

Table 9.Chi-square test results for WASREPC * year first gained certificate.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.135[b]	1	.713		
Continuity Correction[a]	.000	1	1.000		
Likelihood Ratio	.252	1	.615		
Fisher's Exact Test				1.000	.882
Linear-by-Linear Association	.133	1	.715		
N of Valid Cases	68				

a. Computed only for a 2x2 table

b. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .12.

Data supplied from the government research partners (Figures 1 & 2) indicated that there had been a total of 201 crane accidents reported to or investigated by them in the 10 years since 1994. Out of this total there were 25 or 12.5% which involved operators who were certificated post 1994. Of this group 19 or 76% came from the mining industry and 6 or 24% from the construction industry. The collected data indicated that the remaining 176 or 87.5% of accidents could be attributed to operators who were certificated prior to 1994.

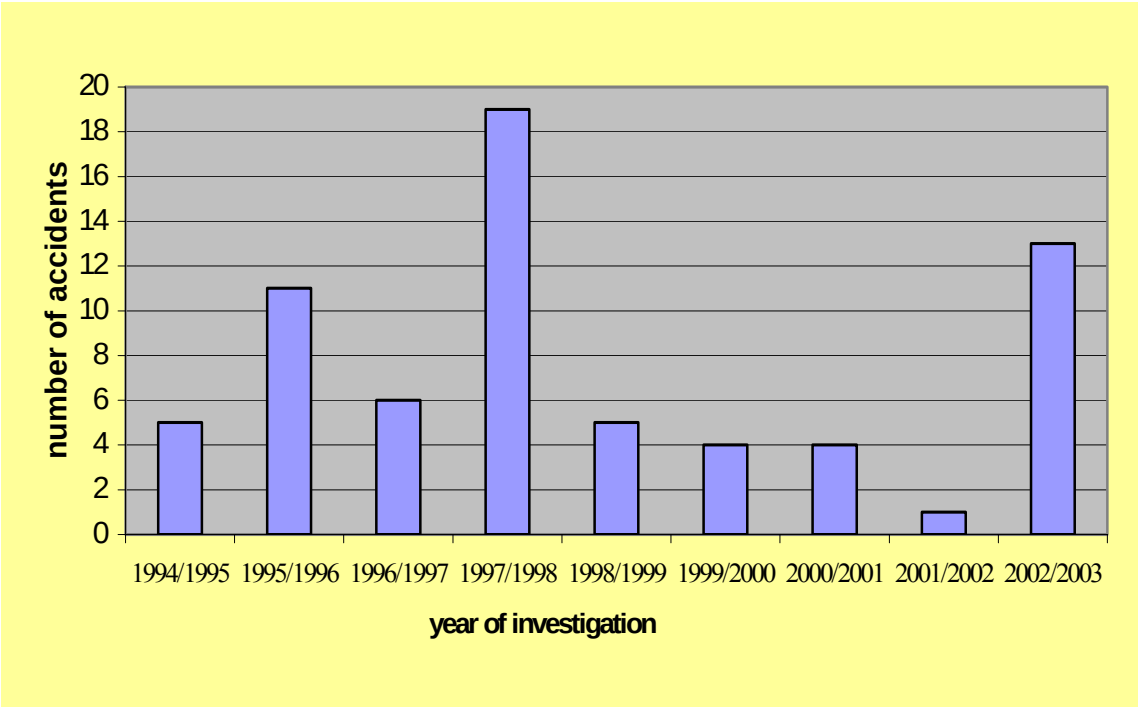

Figure 1. Number of accidents involving lifting cranes and which was the subject of accident investigations by WorkSafe for the period 1994 – 2003.

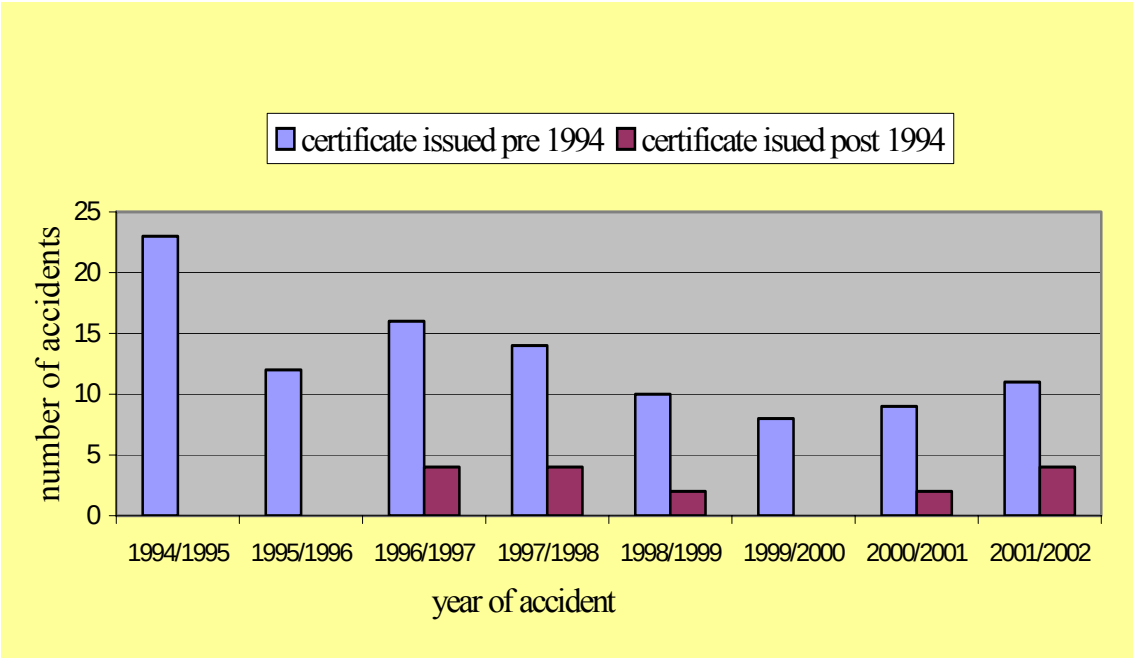

Figure 4. Number of accidents that involved lifting cranes in the mining industry 1994 – 2002 by certification year of operator (pre or post 1994).

Table 10. Variables and outcome of the equation for logistic regression.

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	TOTMONTH	-.015	.005	8.156	1	.004	.985	.975	.995
	YOCERT(1)	-1.390	.766	3.293	1	.070	.249	.055	1.118
	Constant	1.459	.453	10.379	1	.001	4.302		

a. Variable(s) entered on step 1: TOTMONTH, YOCERT.

Table 10 shows the results of the logistic regression analysis conducted between the variables TOTMONTH and YOCERT. These figures had to be inverted and then recalculated, as the way in which they were presented (TOTMONTH) odds ratio (OR) of 0.985 with a 95.0% C.I. of 0.975, & 0.995 and YOCERT(1) odds ratio (OR) of 0.249 with a 95.0% C.I. of 0.055, 1.118 in the printout were actually representing the chances of not being involved in an accident. The new values for being involved in an incident were then (TOTMONTH) OR = 1.015 (1.01, 1.026) and (YOCERT (1) OR = 4.02 (0.89, 18.18).

Table 11. Outcomes from the logistic regression TOTMONTH * YOCERT (1).

		B	S.E.	Wald	df	Sig.	Exp(B)	95.0% C.I.for EXP(B)	
								Lower	Upper
Step 1[a]	TOTMONTH	.007	.004	3.570	1	.059	1.007	1.000	1.014
	YOCERT(1)	1.384	.712	3.774	1	.052	3.990	.988	16.117
	Constant	-.629	.477	1.737	1	.187	.533		

a. Variable(s) entered on step 1: TOTMONTH, YOCERT.

The results of the data presented in Table 11 are very similar to those of the previous logistic regression test and can be expressed as OR (odds ratio) (TOTMONTH) = 1.007 (1.000, 1.014) & OR (odds ratio) (YOCERT (1)) = 3.990 (0.998, 16.117).

Whilst not relating directly to statistical data gathered for the research, the following exsert from the literature review is from an article found in the CFMEU, WA Branch journal "The WA Construction Worker" (Winter Edition 2002).

The meeting which was held on the 27th May 2002 involved between 180 and 200 crane operators who had gathered to express their concerns about the current spate of crane accidents that had been occurring. After much discussion a motion was passed at the meeting of these operators and reported by Murphy, (2002, p. 27) where he stated that, "…there was a unanimous show of hands resolving that no driver would exceed their cranes limits from this day onwards". It is felt that the proposing and passing of this motion tends to indicate that there is a culture amongst this group of operators of regularly overloading their cranes.

A meeting at Booragoon was convened in 1990 where a comparable motion was moved and passed during a meeting of over 300 crane operators. Thus it would appear that nothing has changed in the last 10 - 12 years amongst this group of operators in relation to this culture of overloading their machines.

Discussion.

Official WorkSafe figures relating to the number of crane accidents for the period 1994 - 2003 indicated that overall there had only been a total 82 events in that 10 year period. These figures are confusing and not truly reflective of the actual situation in the state at the time. All these figures tended to do were to highlight the inadequacies in the reporting arrangements for crane accidents and incidents which existed at that point in time.

If this were not the case then there would have been no cause for concern amongst the general public and certainly no need for the establishing of the "Crane Safety Standards Working Party" special committee set up by the Minister for Consumer and Employment Protection, Mr J. Kobelke. MLA.

Two of the recommendations of the report tabled in parliament from this working party related to crane operator training. The first of these was in relation to assessing experience through logbooks and the second, that operators should undertake refresher training every 5 years. Experience is a difficult variable to measure, for instance do you measure the length of time a person has been operating cranes or should you measure the variety and intensity of the tasks undertaken whilst operating cranes?

For example, would a person who has operated the same crane doing the same task for 20 years be more experienced than a crane operator who has worked out of a crane hire yard operating several different makes and tonnage cranes for a period of only 5 years? An argument could be put that the first operator may be more "competent" at the particular task they undertake, however there is no case to be put to say that this operator is more "experienced" that the latter.

Statistical data generated through the use of the questionnaire revealed some interesting results for discussion. In relation to the year of certification and accident rates amongst operators the correction value in the table can be seen to be 38 .05 and with an associated Asymp. Significance (2-sided) of .000. These figures tend to indicate that there is an association between the year of certification and being involved in an accident. However the figures do not indicate the strength or the direction of the association.

This association between these variables is supported by the percentages presented in the cross tabulation output of Table 3 Where it can be seen that ninety-eight and a half percent (98.5%) of the respondents who admitted to having been involved in a crane accident were certificated pre 1994 and the other one and a half percent (1.5%) as being certificated post 1994.

The year of certification and incident rates, as with the previous variables, indicated that there may be an association between the year of certification of the operator and whether they had been involved in a crane incident, although the strength and direction of the association was not indicated. The percentages revealed that there were ninety percent (90%) of operators who acknowledged being involved in a crane incident and who were certificated pre 1994, compared to ten percent (10%) certificated post 1994.

A logistic regression was also conducted between the variables year of certification, incident rates and time spent operating a crane since certification, with the latter being the variable that was controlled for, to determine if there was an association between the other two. The data that was generated however was of little use, as no firm significance or odd ratio levels could be determined because of the low number of affirmative responses from the post 1994 group of operators.

The year of certification and the reporting of accidents data was of little or no value because of the low response rate amongst operators certificated post 1994, with only 1 (one) person admitting to being involved in a crane accident. The figures relating to the reporting of incidents needed to be treated with caution because of the closeness of the cell count being below the expected cut-off point of 5 with a minimum expected cell count of 4.38 and 2 cells (33%) being below 5.

The results showed that with a Pearsons Chi-square value of 31.000, with 2 degrees of freedom and an Asymp. Significance (2-sided) of .000, there was a possibility of a trend developing between the year of certification and whether or not they would report being involved in a crane incident.

The results of the logistic regression test that was conducted on the variables TOTMONTH (Total Months Operating Cranes) & YOCERT (Year of Certification) can be found in Table 10. The new figures for the OR (odds ratio) and the 95.0% upper and lower C.I. (confidence intervals) were calculated because the old ones being presented in the SPSS print out were for the odds of not being involved in an incident. Whereas, the odds of being involved in an incident was the one required.

The new value for the OR of 1.015 for the TOTMONTH variable would be tending to indicate that the longer a person has been operating a construction crane then the more likely they are to have been involved in an incident. As the variable is continuous this ratio will increase proportionate to the total length of time spent operating cranes (in months). With the categorical variable (YOCERT(1)) the OR = 4.02 is indicating that the group who were certificated pre 1994 may be up to four times more likely to be involved in an incident than those certificated post 1994.

A logistic regression analysis was conducted between the variables YOCERT, TOTMONTH and REPINC. Unlike the previous output the data generated for this calculation did not need to be manipulated, as the measured outcome was correct. The results found in Table 11 reveal figures similar to those that were generated for the previous calculation. The operators who were certificated pre 1994 would appear to be up to four times more likely to be involved than those certificated post 1994 with an OR = 3.990 (C.I. 1.000, 1.014: .988, 16.117).

The individual logistic regression tests, which were conducted on the variables of ever being involved in an incident and the reporting or non-reporting of incidents, were consistent. Both tended to indicate that there is a real likelihood that the operators who were certificated prior to 1994 are actually up to four (4) times more likely to be involved in one of these two events than their post 1994 counterparts, with odds ratios of 4.02:1 and 3.990:1 respectively.

Recommendations.

1. The current West Australian, "Occupational Safety and Health Regulations" (1996) need to be reviewed with the view of changing the existing requirements in relation to the reporting of crane accidents within their area of control. The system needs to be brought into line to reflect the requirements which appear in the West Australian "Mines Safety and Inspection Act" (1994) in relation to these events.
2. The employers' attitude to the current method of crane operator training needs to be established.
3. The apparent culture of consistently overloading cranes that exists amongst a certain group of operators, need to be investigated to determine the root causes and solutions.

4. The Western Australian Department of Industry and Resources need to alter their requirements for reporting accidents and incidents involving lifting cranes that occur within their jurisdiction to the certificating authority (WorkSafe).

Conclusion.

The initial tests conducted on the data were a series of chi-square analysis for independence between variables. The results from the four chi-square tests on the variables suggest that on this occasion the null hypothesis should be accepted.

Research results indicated that there is a real likelihood that the operators who were certificated prior to 1994 are actually up to four (4) times more likely to be involved in either a crane accident or incident than their post 1994 counterparts, with odds ratios of 4.02:1 and 3.990:1 respectively.

There was an inability to establish the exposure patterns of the two different groups in the workplace which makes the drawing of any concrete conclusions difficult. It is clear however, that there is the need for further research to be carried out in the area of crane operator certification training and the methods used to deliver it. Also there would appear to be a need to investigate the current culture of overloading cranes that appears to exist amongst some of the operators.