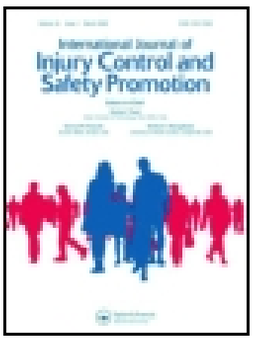

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A study of the effect of OHSAS 18001 on the occupational injury rate in Iran

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The occupational health and safety management system (OHSMS) has been a widely used approach for managing occupational health and safety more effectively worldwide. Despite the interest of organizations in implementing OHSMS in recent decades, few studies have examined the effectiveness of these interventions. This study presents an empirical investigation of the effect of occupational health and safety assessment series (OHSAS) 18001 as a worldwide-accepted OHSMS on the occupational injury rate (OIR) in Iran. This study was carried out in six companies: three OHSAS 18001-certified, and three non-certified, including 998 occupational injuries for 15,842 person-months. A before−after analysis showed a positive safety performance change in one out of the three certified companies. For all 66 study years in the six companies, a negative binomial regression did not indicate a lower occupational injury during the certified years and a repeated measures analysis of variance (ANOVA) did not confirm the effect of certification. The results of this study indicated that the implementation of OHSAS 18001 is not a guarantee of improved safety.

Keywords: OHSMS; occupational injury; intervention; certification; effectiveness; Iran

1. Introduction

The high and growing number of occupational injuries in recent decades worldwide has led to the creation and application of approaches such as the occupational health and safety management system (OHSMS) for the effective management of safety and health. Dalrymple, Redinger, Dyjack, Levine, and Mansdorf (1998) pointed out that the use of OHSMSs is a successful approach for the control of workplace injuries in high-income countries. Occupational health and safety assessment series (OHSAS) 18001 is a worldwide-recognized OHSMS, formulated by international certifying bodies based on a British standard (BS 8800), published in 1999, and revised in 2007 (BSI, 2007). Since the publication of this international standard, a large number of organizations have implemented it worldwide (BSI, 2007, 2009; Chang & Liang, 2009; Hohnen & Hasle, 2011). In line with other workplaces, some Iranian organizations have had an interest in the implementation of this standard to control and prevent occupational injuries (Frick, 2011).

Organizations typically implement an OHSMS to achieve occupational health and safety (OHS) goals such as reducing occupational injuries. However, the implementation of an OHSMS in an organization does not guarantee the reduction of occupational injuries, and its use could not constitute a formula or recipe for success. The level of OHSMS effectiveness varies among industries and organizations, and many factors influence the system's effectiveness. The success of an OHSMS depends on how the adopting organizations implement the requirements of the standard, the features of the interested enterprises, and the external environment (Robson et al., 2007). The commitment of all levels of an organization, especially the top management (BSI, 2007; Gallagher, 2000; LaMontagne et al., 2004), management promises and support (Chen, Wu, Chuang, & Ma, 2009), and employee involvement (LaMontagne et al., 2004) can influence OHSMS effectiveness. In addition, factors such as training, communication, preventive and emergency planning, as well as the monitoring and review of the activities, affect the effectiveness of an OHSMS in an organization (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2009, 2012; Gallagher, 2000). Other influencing factors include the degree of OHSMS implementation, the features of the employed OHSMS, financial resources, and the number of employees available to perform OHS activities. Furthermore, the maintenance of the system has a considerable influence on the development of an OHSMS and its effectiveness (Bluff, 2003). Considering these influencing factors will help adopting organizations to develop their safety management system to perform effectively.

In addition to the factors influencing the effectiveness of an OHSMS, several factors affect the occupational

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injury rate (OIR) in an organization. Lower rates of occupational injuries in organizations are related to employee participation in safety activities, safety training, the commitment of managers and their involvement in safety, as well as good communication between managers and employees. Other characteristics of organizations with low OIRs include the investigation of accidents, having a good record-keeping system and a reward system, using safety rules and procedures to perform activities in a safe manner, and employing a feedback system on safety management practices. Furthermore, hazard identification, machine guarding, the existence of a safety committee, housekeeping, and the supply of personal protective equipment enhance the safety performance in workplaces (Bentley & Haslam, 2001; Harper et al., 1996; Mearns, Whitaker, & Flin, 2003; Shannon, Mayr, & Haines, 1997; Vinodkumar & Bhasi, 2011). National regulation and management systems also influence the safety performance (Kjellén, 2012). Thus, effective execution of these safety management practices will improve the safety performance in organizations.

Studies measuring the effectiveness of OHS interventions will help organizations to determine whether they have used their resources to achieve the OHS objectives. The ultimate aim of organizations in conducting the interventions is the prevention of occupational injuries and diseases (Rivara & Thompson, 2000). Organizations attempt to apply prevention strategies in an effective way; however, some enterprises do not measure their effectiveness but may rather count on their external image in the media and business (Frick, 2011). Frick (2011) stated that the monitoring of OHS outcomes is essential in OHSMS effectiveness studies to determine whether the management system is effective in practice. Furthermore, the rate of injury reduction is an important indicator for the measurement of intervention effectiveness, and it is the principal criterion for OHSMS success (Gallagher, 2000). This measurement can be carried out using a quantitative measure as well as by determining the association between an interventional programme and the injury rate (Iyer, Haight, Del Castillo, Tink, & Hawkins, 2005; Robson et al., 2007). Therefore, the measurement of safety performance enables organizations to become aware of the effectiveness of implemented interventions such as OHSAS 18001 in improving the safety performance level.

Despite the interest of most organizations in implementing an OHSMS, in particular the OHSAS 18001 standard, in their sites, few studies have examined the effectiveness of these interventions. Furthermore, a limited number of investigations have considered OHSMS effectiveness in reducing occupational injury (Fan & Lo, 2012; LaMontagne et al., 2004; Robson et al., 2007). Past studies have found that an OHSMS has a positive and direct effect on decreasing the injury rates in organizations (Fernández-Muñiz, Montes-Peón, & Vázquez-Ordás, 2007; O'Toole, 2002). In their systematic review, Robson et al. (2007) identified few studies on OHSMS interventions that showed positive effects on injury rates in organizations. Furthermore, Vinodkumar and Bhasi (2011) stated that organizations certified with OHSAS 18001 had better safety management practices and fewer accidents. Bottani, Monica, and Vignali (2009) found that safety management system adaptors experienced substantially lower accident rates. The development of the OHSMS is also an important factor in reducing occupational injuries. Likewise, Fernández-Muñiz et al. (2009) indicated that organizations with more developed systems experience a lower number and severity of injuries.

In contrast, some authors have claimed that OHSMS interventions are not effective enough. Eisner and Leger (1988) found that the international safety rating system (ISRS) was not effective in improving safety and decreasing the fatality rate in South African mines. According to prior studies, Frick (2011) demonstrated that the ISRS does not significantly correlate with fatalities and reported accidents. The European Agency for Safety and Health at Work studied the effects of OHSMSs in 11 companies around Europe. The number of occupational accidents decreased in five companies after the implementation of an OHSMS and increased in one of the firms (EASHW, 2002). Frick and Kempa (2011) stated that the implementation of an OHSMS in an organization will not guarantee the prevention of severe occupational accidents, and they pointed out the occurrence of an accident in a Swedish company with a fatal outcome and a large explosion in an Esso plant as examples.

As mentioned, the main purpose of OHSAS 18001 is to reduce occupational injuries in adopting workplaces. Moreover, based on the requirements of the standard, the implementation is intended to lead to continual improvement in the safety performance of organizations. Therefore, it is expected that within a few years after the implementation of OHSAS 18001, the OIR will decrease in the workplace. This study aimed to determine the effect of OHSAS 18001 on the OIR in manufacturing companies in Iran.

2. Method

To study the OHSAS 18001 effects on occupational injury, we conducted a study in the west Azerbaijan province in Iran. This study included two workplace cohorts: certified and non-certified. The certified cohort included three companies, which implemented the requirements of the OHSAS 18001 standard and were certified by a certification body. The non-certified cohort also consisted of three companies, which did not implement the standard requirements in their sites. The companies were

Table 1. Number of injured employees and number of employees in the certified and the non-certified companies, by year, 1999 through 2009.

	1999		2000		2001		2002		2003		2004		2005		2006		2007		2008		2009		Average	
Companies	N.ie[a]	N.e[b]	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e	N.ie	N.e
Certified 1	94	463	83	449	70	441	41	436	27	433	26	416	30	409	12	411	21	411	15	422	12	402	39.18	427
Certified 2	14	203	5	203	18	205	7	225	4	230	5	228	3	192	12	195	4	225	10	230	12	228	8.54	215
Certified 3	5	130	1	125	6	126	5	248	8	238	15	234	9	240	3	245	13	243	5	231	4	231	6.72	208
Non-certified 1	13	260	31	264	21	270	15	257	12	254	12	245	17	232	18	210	16	211	6	202	2	196	14.81	236
Non-certified 2	10	180	9	183	7	163	12	143	13	123	9	143	6	133	6	113	8	123	8	108	14	129	9.27	140
Non-certified 3	15	138	11	132	8	135	7	167	6	170	11	216	13	243	14	264	16	283	13	298	20	306	12.18	214

[a] Number of injured employees; [b]Number of employees.

manufactures of beverages, chemical, and electrical products, as well as goods used in construction and agriculture. The main safety hazards of the companies include confined spaces, risk of falls, working with heavy machineries and dangerous chemicals, and working under hot, noisy and extremely fast-paced conditions.

Occupational injury data were collected from the occupational injury documents in the workplaces for each year during 1999−2009. We applied *t*-tests for before−after certification comparisons of the OIRs (annual number of occupational injury/annual number of employees × 100) for all available years in the certified and the non-certified companies. Negative binomial regression (SPSS generalized linear mixed models) was used for modelling the influencing factors on occupational injuries for comparisons of certified and non-certified years among both certified and all companies. The negative binomial distribution is a well-suited method to describe discrete and non-negative events. It is also an appropriate modelling tool when the mean and variance of the data are not approximately equal and the variances of the estimated Poisson model coefficients tend to be underestimated (Poch & Mannering, 1996). Occupational injury was used as dependent variable, and OHSAS 18001 intervention, workplace, and time as independent variables. A repeated measures analysis of variance (ANOVA) was finally used to test the interaction between group (certified vs. non-certified) and years (before vs. after certification).

3. Results

A total of 998 lost time occupational injuries were recorded for 15,842 person-months in the studied cohorts during the study period. The results showed that the number of injuries in the certified cohort ($n = 599$) was higher than in the non-certified ($n = 399$) cohort. Assessment of the average number of employees also indicated that the certified 1 ($n = 427$) and non-certified 2 ($n = 140$) companies had the maximum and minimum active employees over the study period, respectively. Tables 1 and 2 show the number of employees, the number of injured employees, and the injury rates yearly for the certified and the non-certified cohorts.

In a before−after analysis, one out of the three certified companies, certified 1, showed a positive safety performance effect of the certification, $t_{(9)} = 5.74$, $p < 0.01$ (Table 3).

For all 66 study years in six companies, a negative binomial regression indicated that the corrected model was significant [$F_{(9,56)} = 10.32$, $p < 0.001$], and the workplace [$F_{(5,56)} = 14.92$, $p < 0.001$] had significant effects on occupational injury. Furthermore, occupational injuries were higher in certified 1 ($\beta = 1.27$, CI = 0.73−1.81, $p < 0.001$) during the pre-intervention years and the intervention year than during the certified years. A negative binomial regression for the certified companies showed that the corrected model was significant [$F_{(6,26)} = 9.51$, $p < 0.001$], and the workplace [$F_{(2,26)} = 20.14$, $p < 0.001$]

Table 2. Occupational injury rates (injuries per employees) of the certified and non-certified companies, by year, 1999 through 2009.

Companies	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Certified 1	20.30	18.48	15.87	9.4*	6.23	6.25	7.33	2.91	5.1	3.55	2.98	8.95
Certified 2	6.89	2.46	8.78	3.11	1.74	2.19	1.56	6.15	1.77*	4.34	5.26	4.02
Certified 3	3.84	0.8	4.76	2.01*	3.36	6.4	3.75	1.22	5.34	2.16	1.73	3.22
Non-certified 1	5	11.74	7.7	5.83	4.72	4.89	7.32	8.57	7.58	2.97	1.02	6.13
Non-certified 2	5.55	4.91	4.29	8.39	10.56	6.29	4.51	5.30	6.50	7.40	10.85	6.78
Non-certified 3	10.86	8.33	5.92	4.19	3.53	5.09	5.34	5.30	5.65	4.36	6.53	5.92

*OHSAS 18001 certification year.

Table 3. Results of *t*-test for OIR in the certified companies.

	Pre-certification		Post-certification			
Companies	Mean	SD	Mean	SD	*t*	df
Certified 1	15.90	4.66	4.89	1.77	5.74*	9
Certified 2	4.11	2.75	3.79	1.80	0.18	9
Certified 3	3.11	2.04	3.24	1.84	−0.10	9

*$p < 0.01$.

had significant effects on occupational injury. With all 33 workplace years included, a negative binomial regression showed higher occupational injuries in certified 1 (β = 1.62, CI = 1.01−2.22, $p < 0.001$) during the non-certified years (pre-certified and non-certified) than the certified years (Table 4).

A repeated measures ANOVA was computed for five years (two years before, the intervention year, and two years after the intervention) in the certified cohort and the same years in paired companies from the non-certified cohort. The Mauchley's test of Sphericity provided a significance value and the Greenhouse−Geiser estimate of Sphericity (ε) in the SPSS result was less than 0.75; therefore, we used the Greenhouse−Geiser correction (Field, 2009; Leech, Barrett, & Morgan, 2005). The interaction of the year and group did not reach a statistical significance ($F_{(1.03,5.18)} = 1.42$, $p > 0.05$), indicating that the average OIRs did not change over the time in the certified versus non-certified companies. The injury data used for ANOVA have been highlighted in Table 2.

4. Discussion

The purpose of this study was to determine the effect of OHSAS 18001 on the OIR, which was expected to be positive due to the purpose of the certification as well as based on earlier research (Bottani et al., 2009; Fernández-Muñiz et al., 2007; Vinodkumar & Bhasi, 2011). The comparisons of the OIRs before and after the certification revealed that the OIR decreased in one of the certified companies (certified 1), but not in the second and third. The negative binomial regression computed over all 66 study years did not indicate a significant effect of the certification such that occupational injuries were not lower during certified than non-certified years. Similarly, the application of a repeated measures ANOVA did not show a significant interaction between the certification group and the intervention and, thus, failed to show any effect of the certification.

The fluctuating rates of the non-fatal OIR shown in Table 2 may have resulted from the fragile characteristics of the planning and performance of the occupational safety programmes in the companies. Another possible reason is how occupational injuries were registered in the workplaces. Not all occupational injuries were reported by departments such as production and maintenance to the safety department for registration, or perhaps deliberately not registered, especially after certification (see Table 1).

Compared with the national and West Azerbaijan province figures on occupational injury produced by the Iranian Social Security Organization (ISSO), the overall rate in the studied companies is higher (OIR range = 3.22−8.95 and average = 5.83) than the national (0.25) and West Azerbaijan province (0.23) rates reported for all industries (ISSO, 2009). The reason might be that all registered occupational injuries in the companies were not reported to the ISSO if reporting was not required according to the rules of the organization. In addition, some employees might belong to other insurance organizations.

Table 4. Generalized linear mixed models (negative binomial) for occupational injury in the certified and non-certified cohorts.

	Certified and non-certified cohorts data					Certified cohort data				
Variables	β[a]	SE[b]	95% CI[c]	*t*	*p*-Value[d]	β[a]	SE[b]	95% CI[c]	*t*	*p*-Value[d]
Intervention 1 (pre-intervention)	−0.18	0.86	(−1.91−1.54)	−.21	0.83	−0.43	1.03	(−2.55−1.69)	−0.41	0.68
Intervention 2 (during intervention)	−0.44	0.73	(−1.90−1.01)	−.61	0.54	−0.56	0.85	(−2.30−1.18)	−0.66	0.51
Intervention 3 (post-certification)	–	–	Reference	–	–	–	–	Reference	–	–
Workplace 1 (certified 1)	1.27	0.27	(0.73−1.81)	4.70	0.001	1.62	0.29	(1.01−2.22)	5.27	0.001
Workplace 2 (certified 2)	−0.25	0.25	(−0.75−0.25)	−1.01	0.32	0.26	0.39	(−0.55−1.07)	0.66	0.51
Workplace 3 (certified 3)	−0.31	0.33	(−0.98−0.35)	−0.95	0.34	–	–	–	–	–
Workplace 4 (non-certified 1)	0.16	0.22	(−0.28−0.60)	0.73	0.47	–	–	–	–	–
Workplace 5 (non-certified 2)	−0.28	0.23	(−0.75−0.17)	−1.24	0.22	–	–	–	–	–
Workplace 6 (non-certified 3)	–	–	Reference	–	–	–	–	–	–	–
Time	−0.03	0.02	(−0.08−0.18)	−1.28	0.20	−0.09	0.06	(−0.22−0.04)	−1.38	0.17
AICC	444.65 (Poisson = 492.84)					240.08 (Poisson = 277.25)				
BIC	463.85 (Poisson = 510.74)					246.05 (Poisson = 283.24)				

[a] Regression coefficient; [b]standard error; [c]95% confidence interval; [d]*t*-test.

On the other hand, prior studies have revealed that the nonfatal OIR of manufacturing industries is usually higher than the average rate of other industries (BLS, 2013; HSE, 2013).

The implementation of OHSAS 18001 and certification in it are not enough to create an effective system in a certified company (Granerud & Rocha, 2011). In addition, the achievement of a good safety performance may be impossible through only a mechanical application of an OHSMS (Hudson, 2007). OHSAS 18001 is a management tool, and its success depends on how adopting organizations employ the standard requirements to manage OHS. To develop an effective system, a certified company should conduct more efforts to improve the safety culture (Gordon, Kirwan, & Perrin, 2007; HSE, 2001; Santos-Reyes & Santos-Reyes, 2002), implementing all standard requirements and maintaining daily OHS practices.

This study was performed in the companies located in West Azerbaijan province, so the results can be generalized to manufacturing companies in the West Azerbaijan province. One limitation of this study was that it examined only the effectiveness of OHSAS 18001 on the OIR as a reactive (lagging) safety performance indicator, while using a combination of this and proactive key performance indicators (leading) would have better shown the effectiveness of OHSAS 18001 certification in the studied companies. In addition, the results of this study were derived from a limited number of companies due to the limited number of OHSAS 18001-certified companies at the time, and in the place, of the study. Furthermore, the data used in this study consisted of the injuries reported to and registered with the safety department within the studied companies. Finally, the sample of companies represents different manufacturing areas, and this study covers only a limited number of factors that influence the occupational injury rate.

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References

Bentley, T.A., & Haslam, R.A. (2001). A comparison of safety practices used by managers of high and low accident rate postal delivery offices. *Safety Science, 37*(1), 19−37.

Bluff, E. (2003). *Systematic management of occupational health and safety*. National Research Centre for Occupational Health and Safety Regulation. Retrieved from http://asiapacific02.cap.anu.edu.au/sites/default/files/WorkingPaper_20.pdf

Bottani, E., Monica, L., & Vignali, G. (2009). Safety management systems: Performance differences between adopters and non-adopters. *Safety Science, 47*(2), 155−162.

BSI. (2007). *BS OHSAS 18001: Occupational health and safety management systems; requirements*. British Standards Institution, London.

BSI. (2009). *Results of the survey into the availability of OH&S Standards and Certificates, up until 2009-12-31*. British Standards Institution, London..

Bureau of Labor Statistics (BLS), Department of Labor. (2013). Retrieved from http://www.bls.gov/news.release/pdf/osh.pdf

Chang, J.I., & Liang, C.L. (2009). Performance evaluation of process safety management systems of paint manufacturing facilities. *Journal of Loss Prevention in the Process Industries, 22*(4), 398−402.

Chen, C.Y., Wu, G.S., Chuang, K.J., & Ma, C.M. (2009). A comparative analysis of the factors affecting the implementation of occupational health and safety management systems in the printed circuit board industry in Taiwan. *Journal of Loss Prevention in the Process Industries, 22*(2), 210−215.

Dalrymple, H., Redinger, C., Dyjack, D., Levine, S., & Mansdorf, Z. (1998). *Occupational health and safety management systems: Review and analysis of international, national, and regional systems, and, proposals for a new international document*. International Labour Organization, Geneva.

EASHW. (2002). *The use of occupational safety and health management systems in the member states of the European Union. Experiences at company level*. European Agency for Safety and Health at Work, Luxembourg.

Eisner, H., & Leger, J. (1988). The international safety rating system in South African mining. *Journal of Occupational Accidents, 10*, 141−160.

Fan, D., & Lo, C.K.Y. (2012). A tough pill to swallow? The impact of voluntary occupational health and safety management system on firms' financial performance in fashion and textiles industries. *Journal of Fashion Marketing and Management, 16*(2), 128−140.

Fernández-Muñiz, B., Montes-Peón, J.M., & Vázquez-Ordás, C. J. (2007). Safety culture: Analysis of the causal relationships between its key dimensions. *Journal of Safety Research, 38*(6), 627−641.

Fernández-Muñiz, B., Montes-Peón, J.M., & Vázquez-Ordás, C. J. (2009). Relation between occupational safety management and firm performance. *Safety Science, 47*(7), 980−991.

Fernández-Muñiz, B., Montes-Peón, J.M., & Vázquez-Ordás, C. J. (2012). Occupational risk management under the OHSAS 18001 standard: Analysis of perceptions and attitudes of certified firms. *Journal of Cleaner Production, 24*, 36−47.

Field, A. (2009). *Discovering statistics using SPSS* (3rd ed., p. 475). Thousand Oaks, CA: Sage Publications.

Frick, K. (2011). Worker influence on voluntary OHS management systems − a review of its ends and means. *Safety Science, 49*(7), 974−987.

Frick, K., & Kempa, V. (2011). *Occupational health & safety management systems − when are they good for your health*. European Trade Union Institute, AISBL. Retrieved from http://www.etui.org/content/download/4967/49850/file/report-119-EN.pdf

Gallagher, C. (2000). *Occupational health and safety management systems: System types and effectiveness*. Deakin University. Retrieved from http://dro.deakin.edu.au/view/DU:30023519

Gordon, R., Kirwan, B., & Perrin, E. (2007). Measuring safety culture in a research and development centre: A comparison of two methods in the Air Traffic Management domain. *Safety Science, 45*(6), 669−695.

Granerud, R.L., & Rocha, R.S. (2011). Organisational learning and continuous improvement of health and safety in certified manufacturers. *Safety Science, 49*(7), 1030−1039.

Harper, A.C., Cordery, J.L., Klerk, N.H., Sevastos, P., Geelhoed, E., Gunson, C., … Colquhoun, J. (1996). Curtin industrial safety trial: Managerial behavior and program effectiveness. *Safety Science, 24*(3), 173−179.

Health and Safety Executive (HSE). (2013). Annual statistics report for Great Britain, 2012/13. Retrieved from http://www.hse.gov.uk/STATISTICS/overall/hssh1213.pdf

Hohnen, P., & Hasle, P. (2011). Making work environment auditable − a 'critical case' study of certified occupational health and safety management systems in Denmark. *Safety Science, 49*(7), 1022−1029.

HSE. (2001). *A guide to measuring health and safety performance*. Health and Safety Executive. Retrieved from http://www.hse.gov.uk/opsunit/perfmeas.pdf

Hudson, P. (2007). Implementing a safety culture in a major multi-national. *Safety Science, 45*(6), 697−722.

Iranian Social Security Organization. (2009). Statistical yearbooks (2008−2009). Retrieved from http://www.tamin.ir/News/Item/3417/2/3417.html (in Persian).

Iyer, P.S., Haight, J.M., Del Castillo, E., Tink, B.W., & Hawkins, P.W. (2005). A research model − forecasting incident rates from optimized safety program intervention strategies. *Journal of Safety Research, 36*(4), 341−351.

Kjellén, U. (2012). Managing safety in hydropower projects in emerging markets − experiences in developing from a reactive to a proactive approach. *Safety Science, 50*(10), 1941−1951.

LaMontagne, A.D., Barbeau, E., Youngstrom, R., Lewiton, M., Stoddard, A., & McLellan, D. (2004). Assessing and intervening on OSH programmes: Effectiveness evaluation of the Wellworks-2 intervention in 15 manufacturing worksites. *Occupational and Environmental Medicine, 61*(8), 651−660.

Leech, N.L., Barrett, K.C., & Morgan, G.A. (2005). *SPSS for intermediate statistics: Use and interpretation* (2nd ed., pp. 151−152). Mahwah, NJ: Lawrence Erlbaum.

Mearns, K., Whitaker, S.M., & Flin, R. (2003). Safety climate, safety management practice and safety performance in offshore environments. *Safety Science, 41*(8), 641−680.

O'Toole, M. (2002). The relationship between employees' perceptions of safety and organizational culture. *Journal of Safety Research, 33*(2), 231−243.

Poch, M., & Mannering, F. (1996). Negative binomial analysis of intersection-accident frequencies. *Journal of Transportation Engineering, 122*(2), 105−113.

Rivara, F.P., & Thompson, D.C. (2000). Systematic reviews of injury-prevention strategies for occupational injuries: An overview. *American Journal of Preventive Medicine, 18*(4, Suppl. 1), 1−3.

Robson, L.S., Clarke, J.A., Cullen, K., Bielecky, A., Severin, C., Bigelow, P., … Mahood, Q. (2007). The effectiveness of occupational health and safety management system interventions: A systematic review. *Safety Science, 45*(3), 329−353.

Santos-Reyes, J., & Santos-Reyes, D. (2002). *Assessment of safety management systems in the oil and gas industry*. Offshore technology conference, Houston, TX. Retrieved from http://e-book.lib.sjtu.edu.cn/otc2002/pdffiles/papers/OTC14164.pdf

Shannon, H.S., Mayr, J., & Haines, T. (1997). Overview of the relationship between organizational and workplace factors and injury rates. *Safety Science, 26*(3), 201−217.

Vinodkumar, M.N., & Bhasi, M. (2011). A study on the impact of management system certification on safety management. *Safety Science, 49*(3), 498−507.